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OCTOBER 1946

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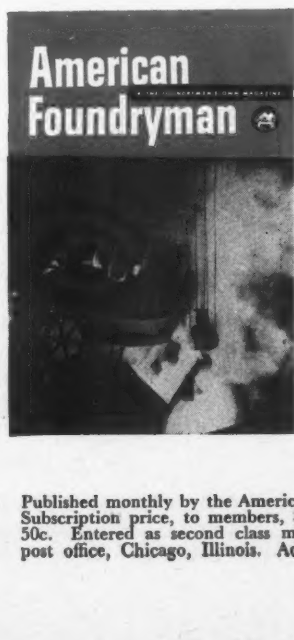

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This Month's Cover

End of the heat. Carbon and graphite electrodes, because of unusual combination of physical, chemical, and electrical properties, are essential in electric arc furnace practice. (See Page 40 of this issue.)

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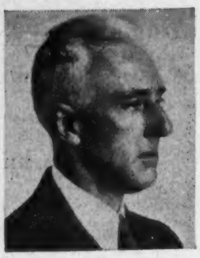
★ OCTOBER WHO'S WHO ★



J. E. Goss

Serving as a supervisor of apprentices at one of the country's largest manufacturing plants has afforded Mr. Goss, author of *Skill and Leadership Through Apprentice Training*, ample opportunity to study the effects of a good apprentice training program. . . . Mr. Goss is a native of Fall River, Mass. . . . Has taken extension courses from Brown University, Providence, R. I. . . . Served his apprenticeship in drafting at Corliss Steam Engine Works, Providence, R. I. . . . Became draftsman for Taunton Locomotive Co. . . . Was instructor of mechanical drawing for five years at Fall River High School. . . . Served as supervisor of apprentices, Brown & Sharpe Mfg. Co., Providence. . . . Present position being industrial activities administrator, Brown & Sharpe Mfg. Co. . . . . Has written extensively for the trade press concerning apprenticeship and has talked before a number of technical societies upon the same subject. . . . Is a member of the A.F.A. Apprentice Training Committee and the Subcommittee on Program and Papers, Apprentice Training Committee. . . . A member of the Providence Engineering Society.

J. E. Rehder

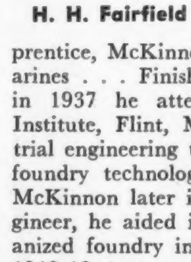
See his article in this issue: *Silicon Pick-Up in Melting Malleable Iron* . . . Born in Bowmanville, Ontario, Canada . . . Received his Bachelor of Engineering degree from McGill University, Montreal, Que., in metallurgy, 1940 . . . Was awarded the Dawson Memorial Fellowship and a prize from ASM for his thesis . . . In 1941 was connected with Walker Metal Products, Windsor, Ont., as chief metallurgist . . . With Bowmanville Foundry Co., Bowmanville, Ont., during 1943-44, the author held the position of assistant manager . . . Is now chief metallurgist, Grinnell Co. of Canada, Toronto, Ont. . . . Prepared a paper last year for presentation before the A.F.A. Ontario chapter relating to malleable iron annealing . . . A member of ASM, ASTM and Physical Metallurgy Club of Ontario.

J. A. Duma

Knock-off Risers, Non-Ferrous Castings is the result of a study conducted at the U. S. Naval Shipyard, Norfolk, Va., by the co-authors, J. A. Duma and S. W. Brinson. . . Mr. Duma was born in Connecticut, city of Branford. . . . A graduate of Yale University, New Haven, Conn., Sheffield Scientific School, with the degree of Bachelor of Science in mechanical engineering. . . . . Following graduation, he became associated with Bethlehem Steel Co., Bethlehem, Pa., metallurgical division. . . . After a year in the laboratory was transferred to the forge specialty shop and was made metallurgical observer; annealer foreman; and turn foreman of heat treating and forging. . . . In 1934 he became connected with U. S. Naval Shipyard, Norfolk, Va., as metallurgist, in which capacity he still serves. . . . Liberally contributed many papers, in conjunction with S. W. Brinson, before a number of A.F.A. conventions. . . . A member of ASM, AWS and A.F.A.

H. C. Winte

Author of *Gray Iron Castings, Section Sensitivity*, H. C. Winte was born in Fort Wayne, Ind. . . . A graduate of Michigan State College of Agriculture and Applied Science, East Lansing, Mich., he obtained his Bachelor of Science degree in mechanical engineering (1931). . . . Entering the castings industry in 1931 he was made foreman, Saginaw Malleable Iron Div., General Motors Corp., Saginaw, Mich. . . . Four years later (1935) he was named cupola foreman, Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich. . . . Severed his connection the following year to become melting superintendent, Fairbanks-Morse Co., Beloit, Wis. . . . Appointed plant metallurgist, Worthington Pump & Machinery Corp., Buffalo, N. Y., the author has been affiliated with this firm since 1940. . . . Active worker on various A.F.A. committees he is one of the chapter and college representatives, Committee on Cooperation with Engineering Schools; a member of the Committee on Inoculation and Chairman, Committee on Chill Tests, A.F.A. Gray Iron Division. . . . Co-author of a recent paper on gates and risers published by the technical press. . . . Member of ASM, Gray Iron Research Institute and American Foundrymen's Association.



H. H. Fairfield

H. H. Fairfield, co-author with Henri Louette and A. E. Murton of the paper *Core Sand, Purchasing Factors*, was born in St. Catharines, Ont., Canada . . . Entering the foundry industry in 1933, the author was foundry apprentice, McKinnon Industries, St. Catharines . . . Finishing his apprenticeship in 1937 he attended General Motors Institute, Flint, Mich., obtaining industrial engineering training; specializing in foundry technology . . . Returning to McKinnon later in 1937 as foundry engineer, he aided in establishing a mechanized foundry in that plant . . . From 1940-46 was a member of the staff, Bureau of Mines, Physical Metallurgy Research Laboratories, Ottawa, Ont. . . . His duties during the war years were many, such as being consulting metallurgist for a number of Canadian foundries; performing research on war production problems; and setting up and directing an experimental foundry . . . Recently joined H. W. Dietert Co., Detroit, as foundry consultant . . . A member of the A.F.A. Sand Division's Ex-

ecutive Committee . . . Has written quite extensively for the trade press concerning quality control in metallurgical processes and general foundry practices . . . Is a member of ASM, Canadian Institute of Mining and Metallurgy and American Foundrymen's Association.

J. G. Mezoff

Twenty-six-year-old John G. Mezoff, co-author with M. V. Chamberlin of *Magnesium Castings Quality, Effect of Mold Materials,* was born in Chester, Pa. . . . Matriculated at Purdue University, West LaFayette, Ind., and graduated in 1942 with a Bachelor of Science degree in metallurgical engineering . . . In May, 1942, became associated with Dow Chemical Co., Midland, Mich., as research metallurgist . . . Assumed his present position as production manager, Saginaw Bay Industries, Inc., Bay City, Mich., early in 1946 . . . Holds membership in ASM and American Foundrymen's Association.

A. E. Murton

Co-author with Henri Louette and H. H. Fairfield of *Core Sand, Purchasing Factors* . . . Mr. Murton was born in Calgary, Alberta, Canada . . . Graduated in 1943 from Colorado School of Mines, Golden, with a Bachelor of Science degree in metallurgical engineering . . . Following graduation became affiliated with Consolidated Mining & Smelting Co., Trail, British Columbia, Canada . . . February, 1944, obtained his present position as metallurgist, Bureau of Mines, metallurgical laboratories, Ottawa, Ont., and has been working in the experimental foundry . . . Is a member of ASM and American Foundrymen's Association.

Henri Louette

Co-author (with A. E. Murton and H. H. Fairfield) of the paper *Core Sand, Purchasing Factors* which appears in this issue . . . . Mr. Louette was born in Belgium. . . . Settling in Canada he obtained his technical training at Montreal Technical School, Montreal, Que. . . . Began a twenty-eight year association with Warden King Ltd., Montreal, in 1918 when he was appointed draftsman. . . . Two years later (1920) was promoted to patternmaker. . . . Was made pattern shop foreman in 1930 and maintained that position until 1932 when he was named foundry supervisor. . . . Served as foundry superintendent from 1937-43. . . . At present is factory superintendent. . . . Has spoken before both of the Canadian chapters on sand control problems. . . . A member of the A.F.A. Eastern Canada and Newfoundland chapter he has served on that chapter's board of directors, as its vice-chairman and at present as chairman. . . . An A.F.A. member.

M. V. Chamberlin

See: *Magnesium Castings Quality, Effect of Mold Materials.* . . . Paper is written jointly by M. V. Chamberlin and J. G. Mezoff. . . . Mr. Chamberlin was born in Antrim County, Mich., September 30, 1908. . . . Attended Michigan College of Mining and Technology, Houghton, Mich., and graduated with a Bachelor of Science degree (1931). . . . In 1932 was connected with Chevrolet Grey Iron Foundry Div., General Motors Corp., Saginaw, Mich., as metallographer. . . . Assumed the position of metallurgist with Dow Chemical Co., Midland, Mich., in 1940. . . . Was recently transferred to the Dow plant in Bay City, Mich., as metallurgist. . . . Is a member of the Subcommittee on Physical Properties of Non-Ferrous Foundry Sands at Elevated Temperature, A. F. A. Foundry Sand Research Project. . . . Prominent in the activities of the A. F. A. Saginaw Valley chapter, he recently served as secretary-treasurer and is now vice-chairman of that chapter. . . . Has spoken, upon occasion, before meetings of technical societies on foundry mold materials. . . . Member of ASM and of A.F.A.

T. L. Nelson

Laconia, N. H., is the birthplace of T. L. Nelson, author of a technical paper on electrodes which appears in this issue . . . A graduate of Cornell University, Ithaca, N. Y.; class of '16. . . . From 1916-18 was connected with Ansco Co., Binghamton, N. Y., as research chemist. . . . The following year (1919) was acid supervisor, E. I. du Pont de Nemours & Co., Jacksonville, Tenn. . . . Affiliating with National Carbon Co., Inc., Niagara Falls, N. Y., in 1919 he was named technologist. . . . Appointed head of works laboratory in 1923. . . . Moving to the Cleveland plant in 1929, the author was assigned to the quality control department and then to the works manager's department. . . . Returning to the Niagara Falls division in 1944 he was made manager, electrode service department, the position he holds at the present time. . . . Has written papers for various societies concerning electrode manufacture, nature and properties, and applications in the electrometallurgical and electro-chemical industries. . . . Member of A.F.A. . . . Author of, *Electrodes, Carbon and Graphite, Acid Electric Practice,* a discussion of the generally unappreciated broad scope of carbon's role in industry—and, therefore, in our daily lives.

S. W. Brinson

Risers, always a subject of interest to all foundrymen, is the topic discussed in the paper *Knock-off Risers, Non-Ferrous Castings,* written jointly by S. W. Brinson and J. A. Duma. . . . . Mr. Brinson began his affiliation with the U. S. Naval Shipyard, Norfolk, Va., November, 1906, as an electrical helper. . . . In 1909 left the shipyard to attend Virginia Polytechnic Institute, Blacksburg, Va. . . . Receiving his electrical engineering degree, Mr. Brinson, in 1913, resumed his association with the Naval Shipyard. . . . Was named teacher of mathematics in the apprentice school. . . When the shipyard installed a Tropenas converter, Mr. Brinson was called upon to establish a branch laboratory in the foundry. . . . Was appointed assistant to the shop superintendent in 1916. . . . In 1930 he was made master molder (foundry superintendent), the position he maintains at the present time. . . . Mr. Brinson, in collaboration with J. A. Duma, has presented a number of papers before A.F.A. conventions dealing primarily with steel foundry practice. . . . Holds membership in American Foundrymen's Association.

NEXT MONTH

Among the outstanding and valuable technical papers in the November issue of AMERICAN FOUNDRYMAN will be discussions of: mechanical shakeouts, by J. L. Yates, formerly with Worthington Pump & Machinery Corp., Buffalo, N. Y.; bronze castings, J. T. Robertson and R. G. Hardy, both formerly associated with the Naval Research Laboratory, Washington, D. C.; homogenization heat treatment of cast steel, P. C. Rosenthal and J. G. Kura, Battelle Memorial Institute, Columbus.

THE ENGINEERING GRADUATE AND THE FOUNDRY INDUSTRY

ALTHOUGH OTHER, and the more glamorized, fields of engineering endeavor continue to attract hundreds of young men each year into industries comparatively well supplied with technical talent, foundries secure annually no more than a small fraction of the technically trained graduates needed to fill their requirements.

World War II effected a redistribution of manpower in production and manufacturing but, despite the fact that it did dramatize the importance of castings and the foundry process of manufacture, it failed to bring additional technical help into the Nation's foundries.

The fault lies largely with the industry. Important, basic, but poorly advertised, the castings industry has made only feeble, unintelligible and, consequently, unavailing gestures in the direction of engineering college graduates and other technically trained men.

Meanwhile, failure of commerce and industry to convert rapidly to peacetime operation is traceable, in no small part, to inability of foundries—short of trained men—to provide sufficient castings. A basic commodity, castings are highly essential both to peace and war; and the present shortage of castings serves but to re-emphasize the nationwide importance and significance of the foundry industry.

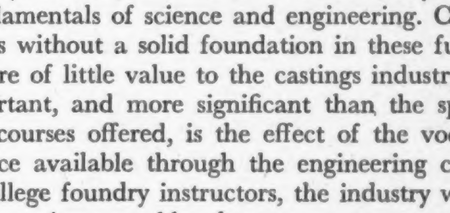
Foundries must recognize that an industry based on complex metallurgical and engineering processes can employ technical trained men to high advantage. Foundry management should appreciate, too, that, faced with an unprecedented peacetime demand for its products, the cast metals industry presents an impressive opportunity and a provocative challenge to graduates of all engineering schools.

Foundry management should understand that engineering schools can aid their students, and the foundry industry, by offering comprehensive and practical courses in metallurgy, foundry techniques, the characteristics of common cast metals, metallography, casting design, and related subjects. More important than special foundry courses, however, is the necessity for teaching fundamentals of science and engineering. College graduates without a solid foundation in these fundunmentals are of little value to the castings industry.

Most important, and more significant than the special foundry courses offered, is the effect of the vocational guidance available through the engineering college staff. College foundry instructors, the industry will appreciate, have innumerable chances to recount the matchless opportunities awaiting technically trained men in the foundries of America.

Recognizing that informed college engineering staffs are among the foundry industry's best advertisements, castings producers should build and foster closer contact with engineering colleges through their industry-wide association, A.F.A.

For years engineering schools have been the chief source of technical talent for the better-known industries. These schools can easily add to their patrons, and in increasing number, the foundries which need, want and will not be denied, a greater share of graduates.



W. J. MacNeill

W. J. MacNeill, general manager, G.H.R. Foundry Div., Dayton Malleable Iron Co., Dayton, Ohio, has long held a keen and active interest in the problems confronting the foundry industry. Prior to his present position he was with Federal Malleable Co., West Allis, Wis., for twenty-six years, resigning to assume the office he now holds.

DETROIT in '47

51st ANNUAL A.F.A. MEETING

IT'S DETROIT, the Motor, City, in '47!

Hub-city of the nation's gigantic transportation-building industry and, tonnagewise, one of the country's foremost foundry centers, Detroit was the unanimous choice of the Executive Committee of the Board of Directors as the site of the fifty-first annual meeting of A.F.A. The dates—circle them in red on your 1947 calendar!—are April 28 to May 1, inclusive.

Considerations

These factors weighed heavily in favor of the Motor City for '47:

One, Detroit and its progressive A.F.A. chapter had enthusiastically sought and thoroughly prepared for the Association's 1945 convention, only to lose it when a "Year-'Round Foundry Congress" through the medium of AMERICAN FOUNDRYMAN and a restricted, but representative basis, annual meeting in Chicago were substituted as a result of the government's urgent plea to cancel "the big conventions" in a war-time effort to limit demands upon transportation and hotel facilities.

Two, Detroit is easily accessible from the great areas of foundry population east, west, south and in Canada; it offers excellent and ample convention facilities, and it is "familiar ground"—in 1897, then a city of less than 285,000 it was host to the Association's second annual meeting, and it has been the A.F.A. Congress city five times during the past half-century.

Three, and the most compelling of factors, the Detroit chapter, disappointed in '45, heartily reissued its invitation for '47. A. H. Allen of the Penton Publishing Co., chapter chairman, wrote:

"On behalf of the members, directors and officers of the Detroit chapter, it is with a great deal of pleasure that I extend to the American Foundrymen's Association a cordial invitation to hold its '50 plus 1' Annual Convention in Detroit during the week of April 28, 1947. Our board has unanimously approved of this proposal.

"We are reasonably sure of ample hotel accommodations at the Book-Cadillac, Statler and elsewhere at that time, and believe that the high-caliber technical program being planned for that event will add measurably to the prestige of the foundry industry locally, as well as attract a large proportion of the national and international membership.

Interesting Plant Visitations

"Several automotive foundry modernization programs now under way in this vicinity will be completed by next spring, and they will make interesting plant visitation trips for those wishing to inspect mass production gray iron foundry operations.

"I am confident you can depend upon the enthusiastic support of the local chapter if it is the decision of your board to accept this invitation, and we will look forward to announcement of such a decision."

Joining Mr. Allen and other members, directors and officers of

Skyline view of Detroit, where A.F.A. will hold its 51st annual convention, April 28-May 1.

Detroit's Art Center—(left) Detroit Public Library and (right) Institute of Arts.

A. H. Allen (left), Penton Publishing Co., and C. E. Silver, Michigan Steel Casting Co., Chairman, Vice-Chairman, respectivey, Detroit chapter.

the Detroit chapter in an invitation to A.F.A. to meet in the Motor City in 1947 were Mayor Edward J. Jeffries, Jr., the Detroit Board of Commerce, the Detroit Convention and Tourist Bureau, and the Detroit Hotel Association. Mayor Jeffries extended an invitation on behalf of the City of Detroit "with the sincere feeling" that the membership of the American Foundrymen's Association would find their meeting there "exceedingly interesting and educational."

Hotels Book-Cadillac and Statler have been designated as joint headquarters for the fifty-first annual meeting, and present plans are for dual registration facilities.

Official hotel reservation application blanks will be mailed to the entire membership of A.F.A. prior to the first of the new year, for assignments by approximately Feb. 1. All advance requests for hotel reservations for the 1947 convention will be handled by an experienced and thoroughly competent housing bureau, working closely with the A.F.A. National Office and all Detroit hotels. Room reservations for the Detroit meeting will be accepted by the hotels through the medium of the official bureau only.

Hotel Accommodations Set

The National Office has been assured by both the Detroit Hotel Association and the Detroit Convention and Tourist Bureau that facilities for the '47 meeting will be fully adequate. In its letter of invitation to members of the Association, the hotel group emphasizes that "Detroit's many splendid hotels offer ample accommodations for your convention" and that current rates will prevail. The convention and tourist bureau adds that arrangements will be made with the hotels of Detroit "to assure your convention of a clear field and ample hotel accommodations."

The Detroit A.F.A. chapter, host to the '47 meeting, will organize its reception, banquet, plant visitation, ladies and other local congress committees in the very near future, and they will be announced in AMERICAN FOUNDRYMAN when completed.

In its arrangements for the convention, the host chapter will have the enthusiastic support and assistance of all Association members throughout Michigan. Two directors of A.F.A. are Michigan men and Detroiters—James H. Smith of General Motors Corp., and Fred J. Walls of International Nickel Co., A.F.A.'s immediate past president.

With a new "excellence of performance" mark, established by the Golden Jubilee Congress of 1946, to shoot at, the fifty-first annual gathering of the American Foundrymen's Association in Detroit in '47 gives promise of being the most practical, interesting, best-attended non-exhibit convention in the Association's history.

Excellent Program Assured

The zeal and wholeheartedness of the Detroit and other Michigan chapters in the interests of the foundry industry and A.F.A.; the intent of the Association's various divisions and program and papers committees (already at work) to make every '47 convention presentation a worthwhile contribution to the literature of the castings industry, plus the eagerness of foundrymen to exchange ideas helpful in solving their current production problems and to become fully informed on new developments, practices, processes and techniques, are excellent assurances of a hither-

(Concluded on Page 62)

GENERAL TECHNICAL PROGRAM BEING FORMED

MAGNESIUM CASTINGS QUALITY

EFFECT OF MOLD MATERIALS

M. V. Chamberlin
and
J. G. Mezoff
The Dow Chemical Co.
Midland, Mich.

In recent years aluminum and magnesium have been extensively used in aircraft components where soundness and quality have been of paramount importance. To expedite the production of sound castings chills were liberally employed by many foundries, although it has been conclusively demonstrated that soundness can be attained by other means.

Many types of chill materials are used by different magnesium foundries. Gray cast iron is the most commonly used chill material because of its low cost, ease of casting into intricate shapes to conform to the contour of the casting, durability, satisfactory cooling capacity, ie., thermal conductivity and specific heat, and ready separation from the molding and core sand by magnetic means.

Frequently, a more drastic chilling medium than gray cast iron is desired, and copper is used to meet this requirement. When greater toughness and durability are required aluminum bronze or steel may be employed. To meet certain conditions, various other materials such as graphite, magnesium "M" alloy, etc., have been tried.

Sand cores generally are considered to have the same relative effect on the metal in the casting, with respect to directional solidification and cooling rate, as the surrounding green sand mold. Therefore, chills are used in cores as in green sand to promote solidification.

Inconvenience and troubles connected with placing chills in cores have led to the development and use of core sand mixtures[3, 4, 5] having increased chilling capacity. These mixtures have been used to form either the whole or parts of a core. The use of these special core sand mixtures involves considerable additional expense because of the increased cost of the raw materials and extra labor in handling.

Fundamental Data. The purpose of this work is to evaluate the following items and thereby establish fundamental data on which future research can be advantageously based:

1. Quantitative evaluation as to chilling characteristics of various mold and chill materials.

2. Effect of cooling rates and thermal gradients upon the soundness and mechanical properties of magnesium castings.

Production of sound sand castings has always been the goal of the foundry industry. Recent foundry investigations[1, 2] have clearly demonstrated that soundness in castings is a function of the proper application of controlled directional solidification. Factors lending themselves to the control of directional solidification are numerous. Among those factors which can be readily controlled and which have found prominent application are pouring temperature, pouring rate, riser size and location, gating method, means for keeping the risers hot, and chills.

Review of the Literature. In view of the antiquity of the art of casting and of the magnitude of the foundry industry today, it is disappointing to find so little information in the literature dealing with the effect of the various mold materials on cooling rates, thermal gradients, and mechanical properties of the resultant castings.

Certain mold variables such as moisture content, permeability, bonding material, washes, strength, collapsibility, etc., have been studied extensively. On the other hand, the evaluation of the basic raw materials used for molds and chills in reference to their capacity to influence the way in which the metal cools and solidifies has been neglected.

A review of the available literature indicates that molding materials for casting gray iron and steel have been investigated briefly for their effect on solidification rates and thermal gradients.

Womochel and Sigerfoos[6] have concluded that (1) solidification rates of gray iron castings in green sand molds and in dry sand molds are approximately the same, (2) a variation of moisture content from 4.9 to 7.0 per cent had but little effect upon the cooling rate of the casting, and (3) castings made in bentonite-bonded molds cooled somewhat more rapidly than

Presented at an Aluminum and Magnesium Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 6, 1946.

the same castings made in non-bentonite-bonded molds.

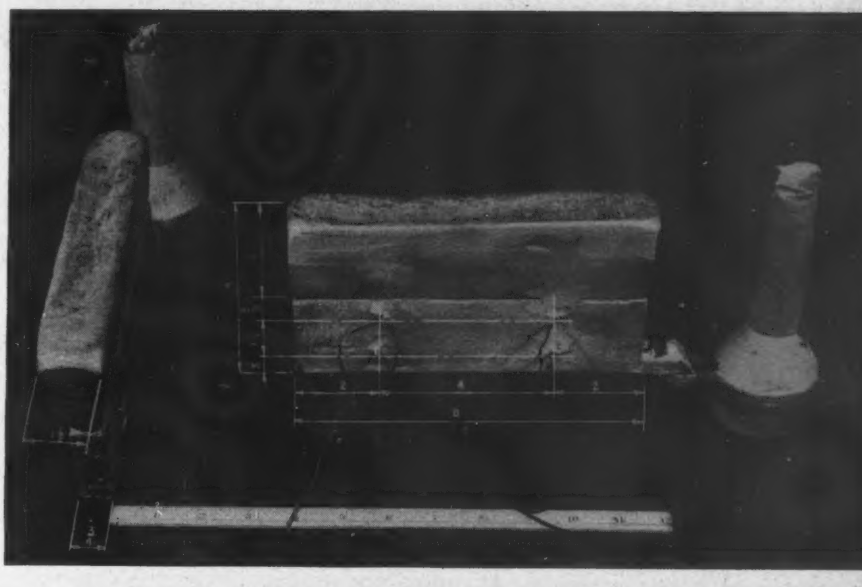
Briggs and Gezelius[7] in their work on steel castings have confirmed, in part, the foregoing conclusions by stating, "The data tend to show that the rate of solidification is practically the same in either of the common types of green or dry sand. Variations in the ordinarily used molding materials result in little more than a perceptible change in the velocity of solidification."

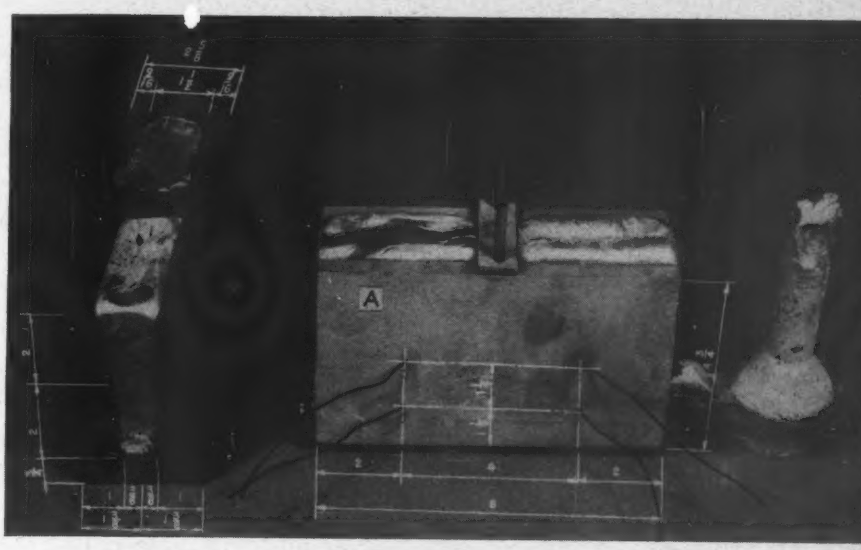
Baker[8] in his extensive work on porosity and unsoundness in magnesium castings has ascertained that, "Of the many factors which govern the solidification process in the casting, only a limited number can be conveniently varied in practice. From the point of view of freedom from porosity the overriding consideration is to produce and maintain steep temperature gradients from the feeders to the remote parts of the castings, and the most important factors which can be conveniently varied to achieve this object are (*a*) the method of pouring, (*b*) the pouring speed, and (*c*) the pouring temperature and mold temperature."

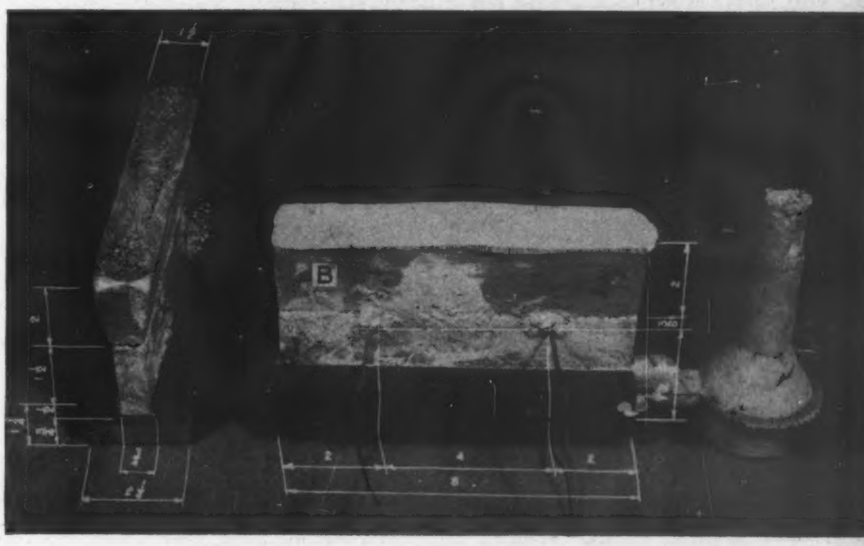
Experimental Procedure

As previously stated, the primary purpose of this study was to demonstrate the influence of mold and core materials on two factors of importance in the casting of magnesium alloys, namely:

1. Relative effect of the various materials on cooling rates and mechanical properties of the resultant castings.
2. Magnitude of the thermal gradients established within the castings by means of combinations of the various materials, and the effect of thermal gradients upon soundness and mechanical properties.

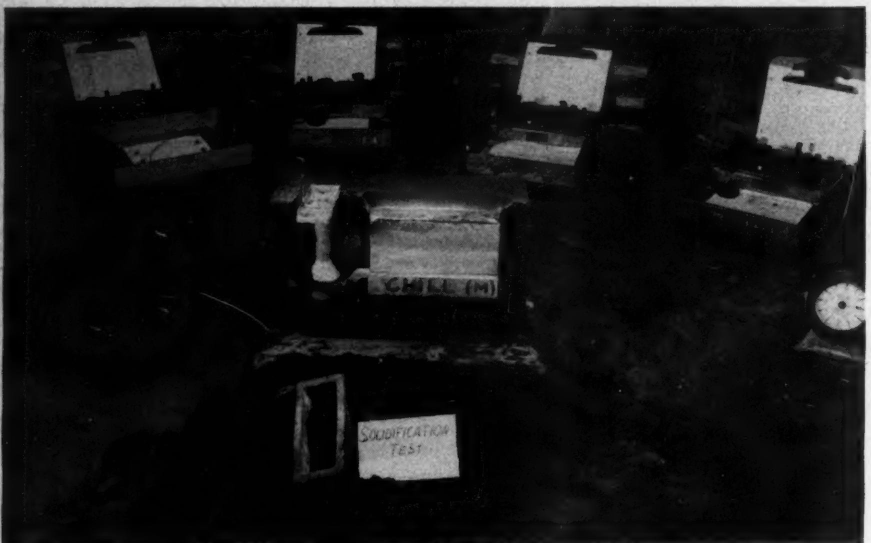


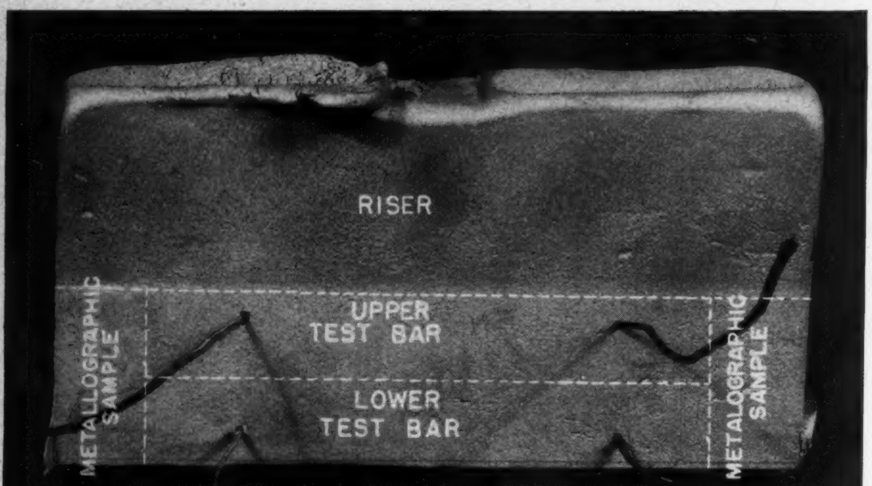


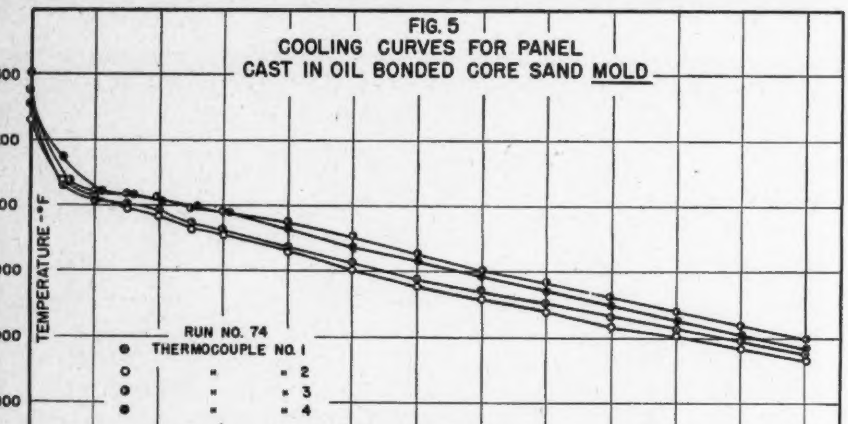


Reading (right) top to bottom: Fig. 1—Panel used for study of effect of mold materials upon cooling rates, thermal gradients and properties.

Fig. 2—Locations of thermocouples and dimensions of (A) molds and (B) chills used for cooling-rate studies of mold materials.







Casting Type Selected. A panel casting ¾-in. thick, 2-in. high and 8-inch long was arbitrarily chosen for these tests. A riser 2-in. high, 8-in. long and tapering from a ¾-in. width at the base to 1½-in. at the top was selected so as to produce a radiographically unsound casting when made in green sand.

A radiographically unsound casting was desirable in that a better qualitative evaluation of the effect of cooling rates and thermal gradients upon the soundness and mechanical properties could be obtained than with a casting which was basically sound. Figure 1 is a photograph of a panel casting with gating, risering, dimensions, and thermocouple locations shown.

Description of Chills and Molds. For studying the relative cooling rates of various mold materials, a mold such as is shown in Fig. 2A was used. In this mold, 80 per cent of the surface area of the test panel and riser are in contact with mold material which is varied from run to run. The remaining 20 per cent of the panel surface is in contact with molding sand ends (8 per cent) or atmosphere (12 per cent).

In studying thermal gradients and their effect upon mechanical properties, an entirely different problem is encountered and a different sort of mold must be used. In this case, a chill (Fig. 2B) whose composition is varied from run to run is placed along the bottom of the mold.

This chill contacts 15 per cent of the surface area of the panel and riser, and provides maximum directional solidification and thermal gradients. The size of this chill is larger than normal foundry practice would employ; thus a range of thermal gradients much broader than found in usual founding operations was studied.

As employed in this paper, the

Reading (left) top to bottom: Fig. 3—Cutaway mold showing position in mold of cast panel and chill.

Fig. 4—Location of test bars and original metallographic samples taken from panels cast in study of mold and chill materials.

terms "mold" and "chill" do not necessarily conform to customary foundry nomenclature. The term "mold," as a matter of convenience and distinction, is applied to the shapes as illustrated in Fig. 2A, or to green sand molds, which are employed in the determination of cooling rates, irrespective of the materials used. On the other hand, the term "chill" is applied to shapes as illustrated in Fig. 2B, which were used essentially for determination of thermal gradients. In some cases these "chills" do not actually act as chills.

Description of Chill and Mold Materials. A few brief comments on the source and some features of the mold and chill materials tested are in order. Composition and properties, with accompanying screen analyses, are shown in Tables 1 and 2.

Gray Iron. The mold was machined from cast 5-in. diameter round stock. It contained coarse graphite, was quite open, and had a density of 6.53. The chill, on the other hand, was machined from a cast 3-in. diameter round of much better quality (density 7.43).

Using "M" Alloy

Magnesium "M" Alloy (1.5 per cent Mn, remainder Mg). Of several magnesium alloys which could be used for mold and chill materials, "M" alloy was chosen for these tests because of its good corrosion resistance and high thermal conductivity, and because it is already in occasional use in production foundries. Both mold and chill were machined from cast "M" alloy blocks of good quality.

Graphite. The mold and chill were machined from 6-in. and 3-in. diameter electrode stock, respectively. The 6-in. diameter stock had more porosity than the 3-in.

Carbon-Bonded Graphite. A carbon-graphite product having a transverse strength of 10,000 psi., 75 scleroscope hardness, thermal conductivity of 12.95×10^{-3} cal/cm/cm^2/°C/sec., and 8 per cent porosity was used as a chill.

Graphite Core. It has been conjectured that graphite additions to core sand mixtures would provide a highly conductive film over the sand grains; and a molding mixture of graphite powder would be still more conductive. Therefore, various mixtures of graphite powder and binders were tried as mold and chill materials.

Table 1

COMPOSITION AND PROPERTIES OF BAKED CORES

MATERIALS*	Core Mixtures (parts based on weight of dry sand): Urea Formaldehyde Bonded Core	Steel Shot	Zircon	Urea Formaldehyde Bonded Graphite	Molding Sand	Plaster
Gratiot Bank Sand (60-65 Fineness No.)	100	30			—	—
Sulphur (325 mesh)	0.78	1	0.78	0.75	—	—
Boric Acid (powder)	0.50	0.7	0.50	0.50	—	—
Cereal Binder	0.625		0.47	0.625	—	—
Core Oil	—	1.8	0.6	—	—	—
Water	4%	1.2%	0.75%	10%	4%	100
Urea Formaldehyde	0.625			10	—	—
Vassar Bank Sand (90-95 Fineness No.)	—			—	92	—
Bentonite	—	0.75		—	4	—
Inhibiting Agent	—			—	4	—
Graphite	—			100	—	—
Chill Shot	—	70		—	—	—
Zircon	—		100	—	—	—
Stucco	—					80
Talc						20
PROPERTIES						
Green Permeability	127	52	28	21	80	0
Green Compression, psi.	1.5	4.8	1.35	9.8	7.0	—
Deformation, in./in.	—	—	—	0.050	0.020	—
Dry Permeability	152	65	40	52	—	7
Dry Compression, psi.	830	—	—	280	160	75
Tensile Strength, psi.	178.5	225	310	5.8	—	—
Hardness	86	95	93	85	—	—

SCREEN ANALYSIS

	Retained on Screen, per cent: Bank Sand		Steel Shot			
Sieve No.	*Gratiot*	*Vassar*	*28X*	*No. 40*	*Zircon*	*Graphite*
12	0.0	0.0			—	35.0
20	0.2	0.0			—	31.2
30	0.4	0.0	4.02	2.63	—	20.2
40	1.8	0.2	93.26	95.28	0.06	7.2
50	6.9	0.3	2.72	2.04	0.02	1.4
70	22.7	5.0		0.05	0.22	1.2
100	62.9	45.0			17.03	1.0
140	4.7	35.2			67.61	1.0
200	0.2	12.6			14.92	0.4
270	0.0	0.6			0.12	0.4
Through 270	0.2	1.1			0.02	1.0
Fineness No.	64	91.2	29.8	28.9	100.8	
Distribution No.	50	83.2				

*Trade names of products used may be obtained from the authors.

Of the various mixtures tried, the only one which could be used for this purpose consisted of 100 parts graphite, 10 parts urea-formaldehyde binder, and 10 parts water. This formed a spongy mass which has considerable tendency to spring back on ramming. The molds and chills used had a poor surface and were too weak to consider for use in a production foundry.

Core Sands. Three typical core sands were used in these tests. The urea formaldehyde bonded core mixture conforms to the practices employed in many magnesium foundries. The other two, steel shot and zircon mixtures, have been used under the assumption that they had chill characteristics.

Protective Spray

Both the steel shot and zircon cores, employing an oil binder, were given a protective spray before use because of loss of agent during baking at temperatures of 425-475° F. Urea formaldehyde-bonded cores, on the other hand, were not sprayed, since they were baked at lower temperatures of 300-350° F. with consequent greater retention

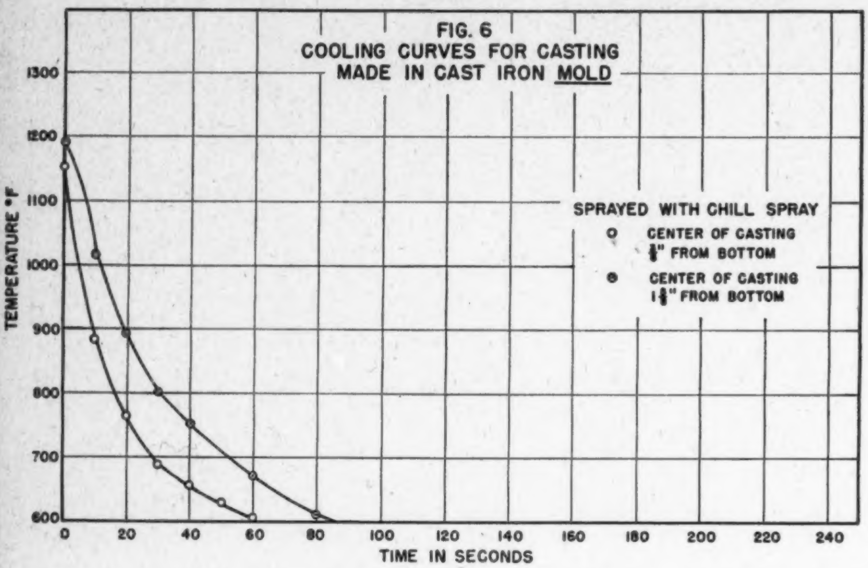


FIG. 6
COOLING CURVES FOR CASTING MADE IN CAST IRON MOLD

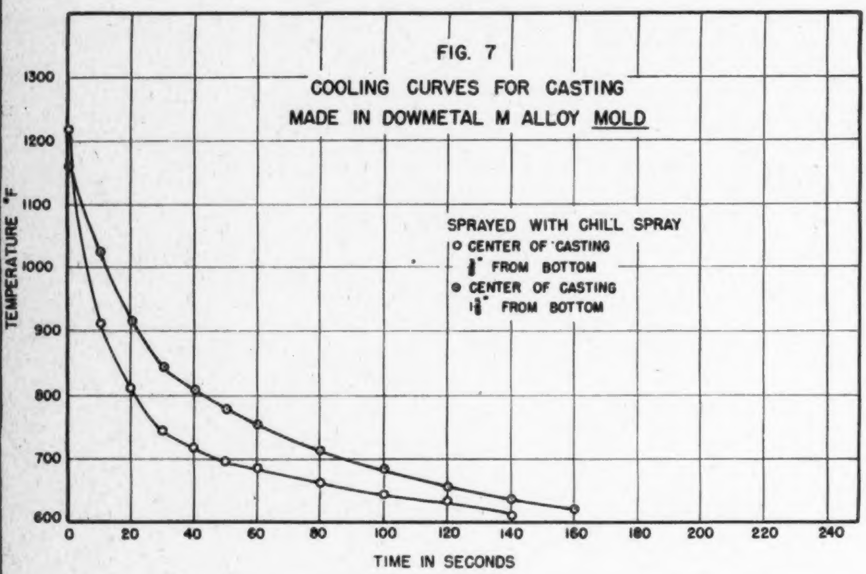


FIG. 7
COOLING CURVES FOR CASTING MADE IN DOWMETAL M ALLOY MOLD

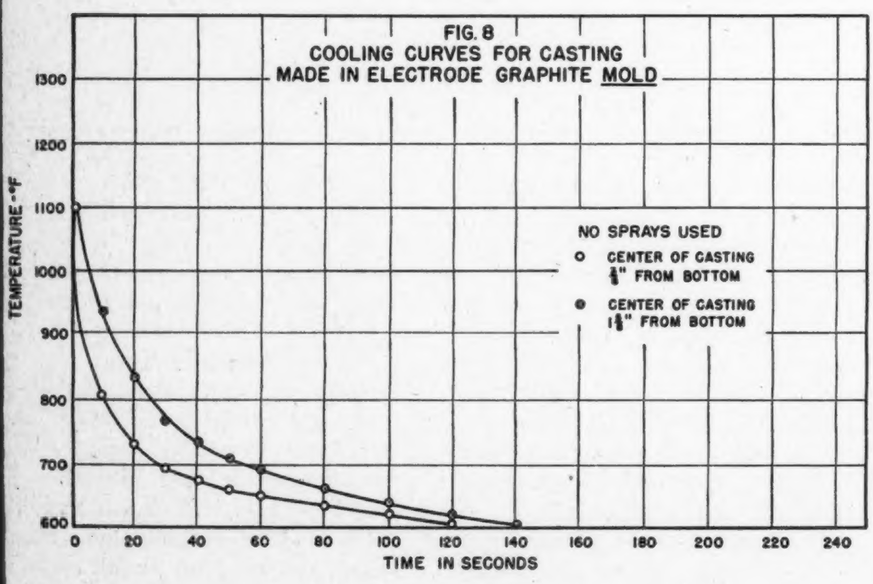


FIG. 8
COOLING CURVES FOR CASTING MADE IN ELECTRODE GRAPHITE MOLD

of protective agent. Table 3 shows the composition of core sprays.

Molding Sand. The molding sand employed in these tests is a fluoride inhibited type commonly used in magnesium foundries. Its composition and properties are shown in Table 1. Green sand molds were neither skin dried nor sprayed.

Plaster. The plaster molds and chills were calcined for periods of 2 hr. at 250° F. The temperature was then increased for a 6-hr. period to 800° F., followed by cooling slowly to 200° F., and maintained at this temperature until used. The plaster surface was given a protective spray just before insertion into the green sand mold.

Casting Procedure. A brief description of the procedure employed for each test follows. The metal molds or chills were sandblasted, sprayed with a wash, and thermocouples anchored in place. The assembly was heated before insertion into a sand mold which had, in the meantime, been rammed to a uniform hardness. The heating was so adjusted that sufficient residual heat remained in the mold or chill for it to be at a temperature of approximately 80° F. at the time of pouring.

Cores

Molds and chills made of either graphite or sand cores were treated in a similar manner except, of course, that they were not sandblasted.

Following insertion of the mold or chill, the green sand mold was closed, and the projecting thermocouples connected to conveniently arranged portable potentiometers.

Simultaneously, 10 lb. of magnesium "H" alloy (6 per cent Al, 3 per cent Zn, 0.15 per cent Mn, remainder Mg) were melted in a steel crucible under No. 310 flux, superheated for 15 min. at 1650-1700° F., cooled to 1450° F., and poured. The metal temperature was determined by means of a 20-gauge chromel-alumel thermocouple enclosed in a ¼-in. seamless steel protection tube and connected to a temperature indicator.

Metal was poured rapidly into the mold, filling it just to the top of the riser. At the moment the mold was filled, the interval timer was started and the four metal temperature readings obtained sim-

ultaneously at 10-sec. intervals for the first 5 min., then at one-min. intervals for the next 5 min., then at 5- and 10-min. intervals until the casting temperature had dropped below 300° F.

Data for the cooling curves of the panel were obtained manually by means of portable potentiometers connected to four 24-guage glass-insulated iron-constantan thermocouples located at definite positions within the casting, as shown in Figs. 1 and 2. The thermocouples were held in position either by anchoring in holes drilled through the mold or chill or by embedding in the molding sand. The thermocouple positions chosen are shown in Table 4.

All thermocouple hot junctions were located at equal distances from the sides of the casting. Location of the thermocouples at 2-in. from each end of the casting was for the purpose of mitigating any end effect from dissimilar materials. Figure 3 is a cutaway view of a mold showing the position of the panel and chill, and general arrangement of equipment for these tests.

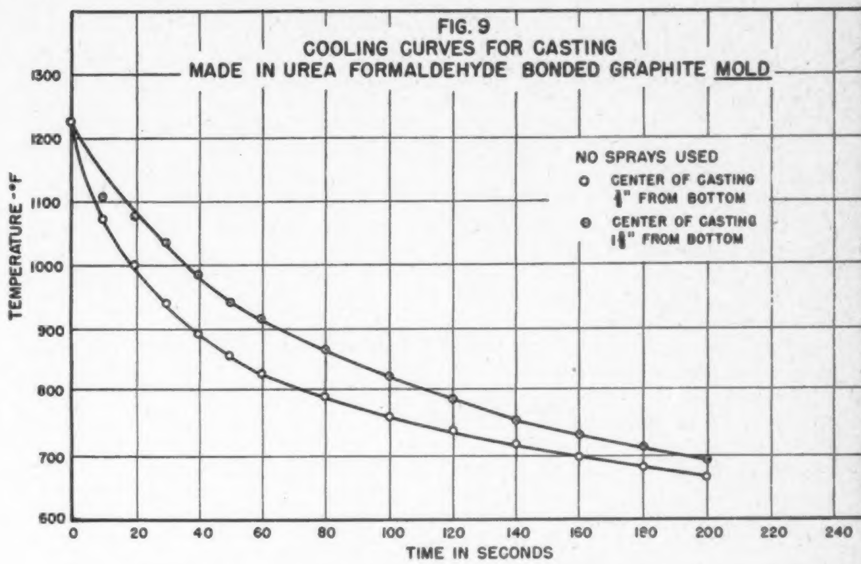
Casting Design

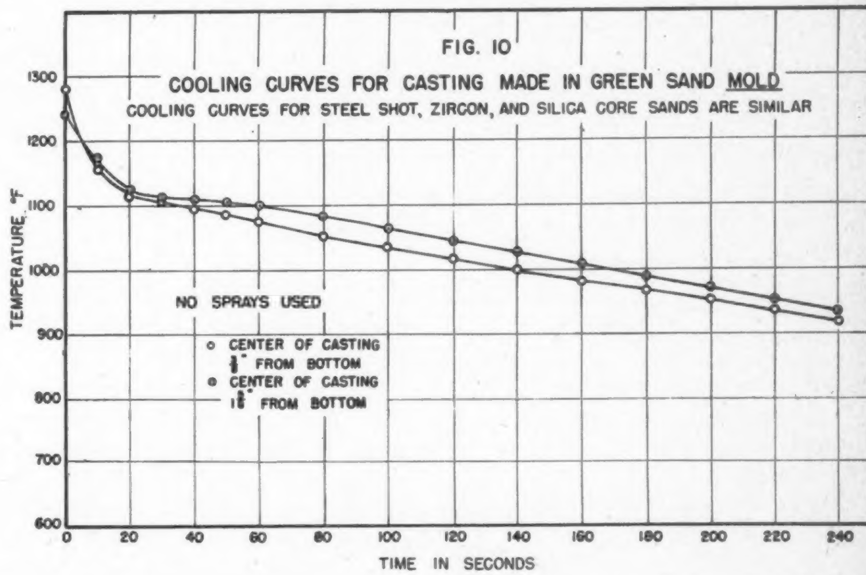
A few additional tests were conducted in green sand molds in which the width of the panel and riser size were varied as shown in Table 5. This was done to learn the influence of casting design upon the variables under study.

Duplicate runs were made for some conditions in which chlorinated[9] metal was used to determine its effect upon the quality of the casting. Chlorination is used in many foundries for degassing and refining the metal. A chlorination treatment was employed in which about 2 per cent chlorine was passed through the metal at 1350 to 1400° F.

Panel Testing. After the cooling curves were obtained each panel was radiographed, then given a heat treatment in an atmosphere of 1 per cent SO_2. The heating cycle consisted of 2 hr. at temperatures from 500 to 730° F., plus 12 hr. at 730° F., followed by cooling to room temperature in air. These heat-treated panels were then sectioned, as shown in Fig. 4, for metallographic and tensile samples.

Radiographs were arbitrarily grouped into five uniform classes





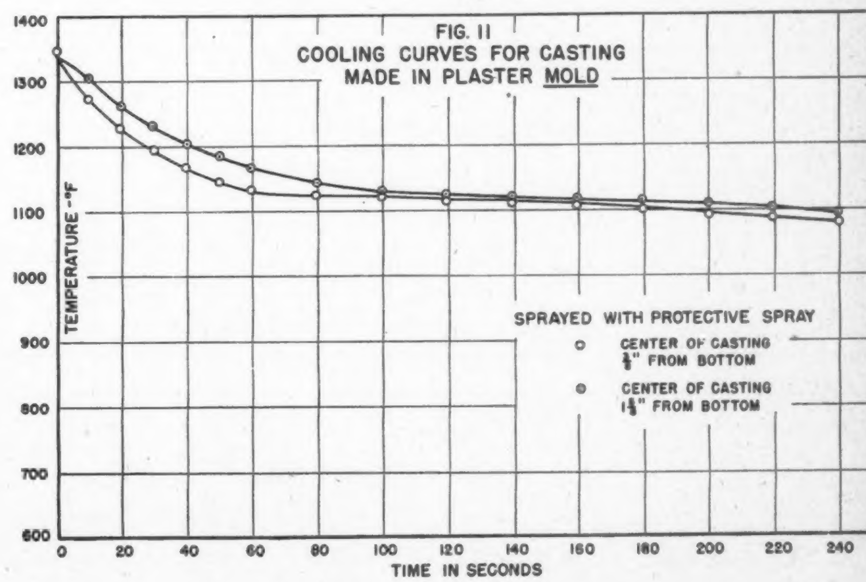


Table 2

PHYSICAL PROPERTIES OF MOLD MATERIALS

Material	Density* gm/cm³	Density* lb/in³	Thermal Conductivity, cal/cm/cm²/°C/sec	Specific Heat	Heat Capacity cal/cm³/°C
Cast Iron					
—Mold	6.53	0.236	0.110(12)†	0.132(12)†	0.863
—Chill	7.43	0.268	0.110	0.132	0.980
Magnesium "M" Alloy					
—Mold	1.76	0.064	0.310(13)	0.249(13)	0.438
—Chill	1.75	0.063	0.310	0.249	0.436
Electrode Graphite					
—Mold	1.55	0.056	0.347(14)	0.195(14)	0.302
—Chill	1.635	0.059	0.347	0.195	0.319
Carbon-Bonded Graphite					
—Chill	1.70	0.0615	12.95×10^{-3}(15)	0.251(15)	0.427
Urea Formaldehyde-Bonded Graphite Cores	—	—	—	—	—
Green Molding Sand	1.76	0.0636	—	—	—
Core Sand					
—Steel Shot	3.22	0.116	10.7×10^{-4}(16)	0.216(16)	0.695
—Zircon	2.27	0.082	7.91×10^{-4}(16)	0.186(16)	0.422
Urea Formaldehyde-Bonded Core	1.60	0.058	10.0×10^{-4}	0.254	0.406
Plaster					
—Mold	0.62	0.0224	—	—	—
—Chill	0.64	0.0231	—	—	—

*Density of solid materials determined by immersion; cores by calculation from weight and volume.
†Figures in parentheses refer to bibliography at end of paper.

Table 3

SPRAY COMPOSITIONS

Chill Wash	
Denatured Alcohol, gal.	4.5
Mazein, qt.	0.75
Talc (white), lb.	5⅝
Protective Spray	
Methanol, gal.	4
Boric Acid, lb.	3¼
NH_4BF_4 (No. 100 inhibiting agent), lb.	1⅝
Talc (white), lb.	5⅝

(Fig. 23), ranging from radiographically sound panels with a rating of one to those with a rating of 5 which exhibited the maximum degree of porosity and unsoundness observed in this study.

Heat treated metallographic samples were examined for average grain diameter, massive compound rating, and porosity. It was observed that a marked gradation of porosity from sprue to far end existed in slowly cooled panels. Therefore, porosity ratings were also determined on the fractured ends of the tensile bars, and it is these values that are presented in Table 6.

Tensile samples were machined to 0.5-in. diameter bars, polished, and tested in tension for elongation, yield strength (0.2 per cent offset), and ultimate strength. Sections from ⅜-in. panels were machined to flat tension bars, polished, and likewise tested in tension. Table 6 presents a summary of the data.

Graphs and Calculation of Data. The data obtained are too voluminous to present as tables and, therefore, are shown entirely in graphical form.

Cooling Curves

Figure 5 shows the cooling curves for four locations, as previously discussed, in a panel cast in a core sand mold. It is observed that the curves for locations 3 and 4 (upper) follow parallel paths and nearly coincide. The same is true for locations 1 and 2.

This concurrence is even more apparent in the panels cooled more rapidly, whether cast in molds or chills. Therefore, the remaining graphs are plotted from the average values of the upper two thermocouple locations (3 and 4) and also from the average of the lower two thermocouple locations (1 and 2).

Cooling Curves. Figures 6 to 12 are time-temperature graphs of panels cast in the various mold and chill materials in which the data for the curves represent the average of at least two, and usually three or more tests. Although readings were taken until the panel temperature had dropped below 300° F., the graphs below 600° F. were practically straight-line functions which merged. Therefore, the graphs are stopped off at 600° F., which is below the eutectic temperature, in order to expand the scale for the promotion of greater clarity.

Cooling Rate Curves. The cooling rates (Figs. 13-21) of the panels cast in the various molds and chills were obtained from the cooling curve data by plotting the average temperature drop (° F./sec.) obtained from two consecutive readings against the average temperature in this interval. These rate

Table 4

THERMOCOUPLE POSITIONS

Thermocouple No.	Position in Casting: From Bottom, in.	Position in Casting: From Sprue End, in.
1	⅜	2
2	⅜	6
3	1⅝	2
4	1⅝	6

Table 5

PANEL WIDTH AND RISER SIZE

	Panel Width, in.	Riser, in. Height	Riser, in. Width	Riser, in. Length	Volume Ratio Riser/Panel
Original Panel	¾	2	¾x1½	8	1.5
Thin Panel	⅜	2	⅜x¾	8	1.5
Large Riser	¾	3	¾x2½	8	3.83

curves serve to accentuate any temperature retardation that may not be apparent in the cooling curves.

Cooling Rate at 1000° F. These values, the average of the lower thermocouple readings 1 and 2, are taken directly from the cooling-rate curves.

Thermal Gradients. These values, in ° F. per in., are obtained from the cooling curves by obtaining the average temperature differential between the upper and lower thermocouple locations over the temperature range of 1100-700° F. for the lower two thermocouples, and dividing by 5/4 (distance between upper and lower thermocouples is 1¼ in.)

Those thermal gradients established between the surfaces and the center of the panel, although appreciable, were not measured or given consideration in the calculations. Figure 22 shows representative thermal gradients established in panels under four different conditions of cooling. For purposes of comparison, Figs. 24 and 25 show respectively the effect of thermal gradient established in the temperature range of 1100-700° F., and of cooling rate at 1000° F., on the ultimate tensile strength of panels.

Average Time to Reach 700° F. These values were obtained from the data for the lower thermocouples.

Experimental Discussion

One of the important characteristics of a mold material for casting metals is its "chilling capacity" or the rate at which it is able to extract heat from the metal in the casting cavity, for most of the heat contained in the liquid casting must be removed through the mold itself.

Therefore, the chilling capacity of the mold material determines to a considerable extent the cooling rate of the casting. Of the factors influencing the solidification of castings, the judicious selection and use of mold materials is perhaps one of the most important.

Chilling capacity of mold materials to be used in casting magnesium-base alloys is of particular interest in the temperature range 1100-700° F., which is the approximate solidification range of the commercial Mg-Al-Zn type ternary

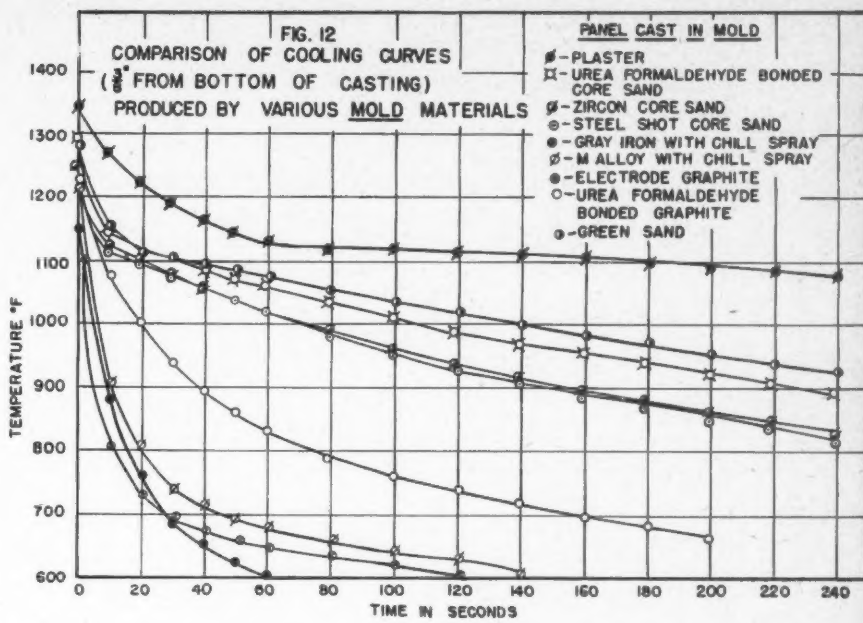


FIG. 12 COMPARISON OF COOLING CURVES (⅜" FROM BOTTOM OF CASTING) PRODUCED BY VARIOUS MOLD MATERIALS

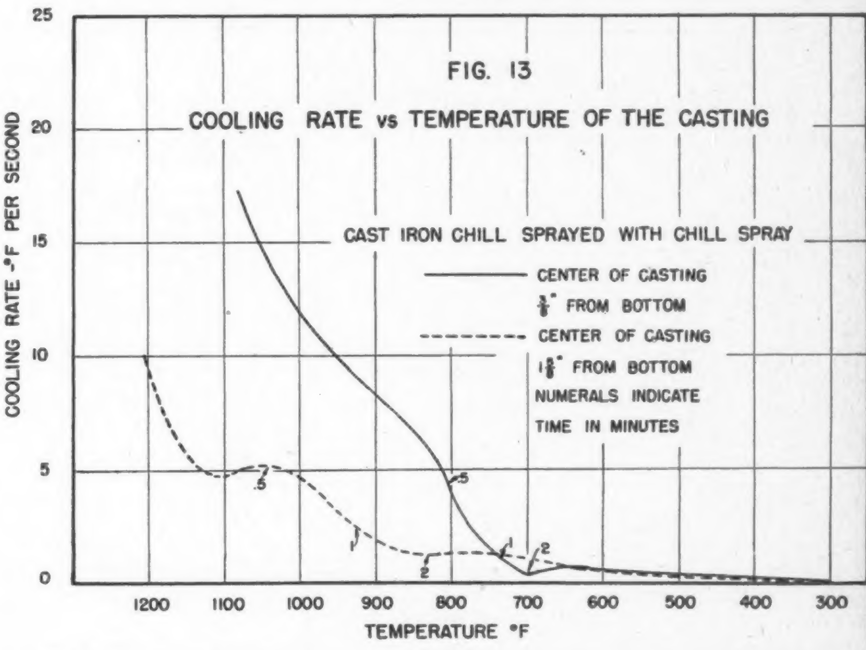


FIG. 13 COOLING RATE vs TEMPERATURE OF THE CASTING

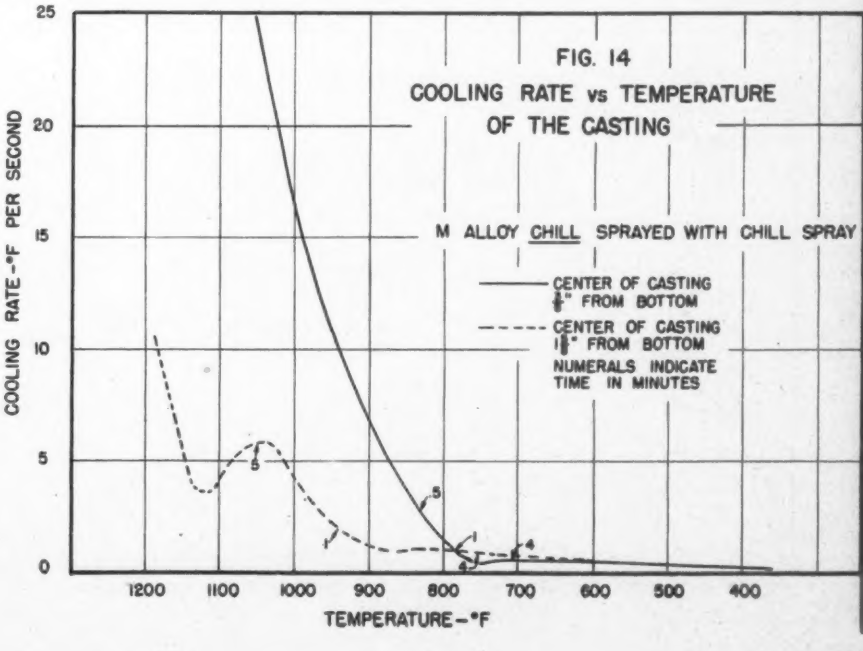


FIG. 14 COOLING RATE vs TEMPERATURE OF THE CASTING

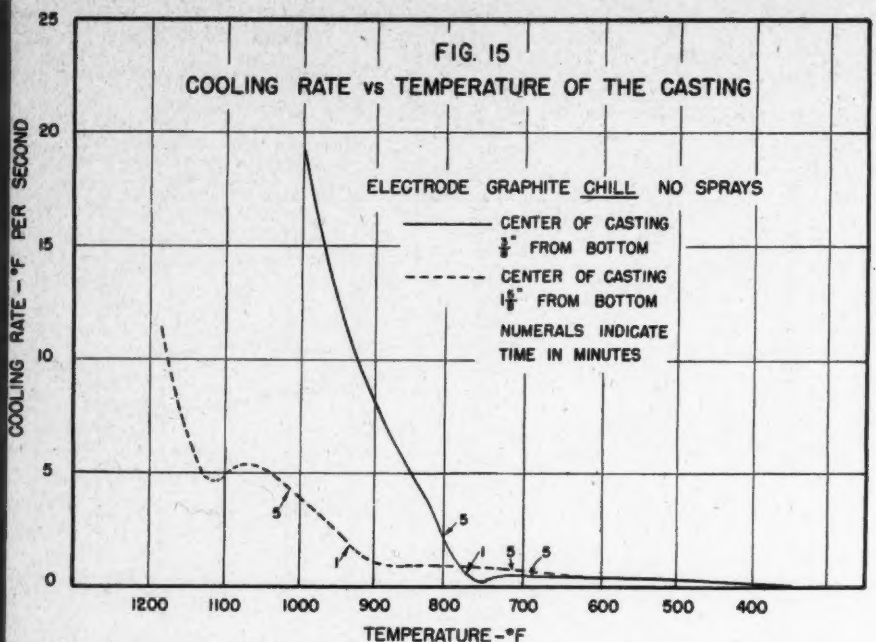


FIG. 15
COOLING RATE vs TEMPERATURE OF THE CASTING

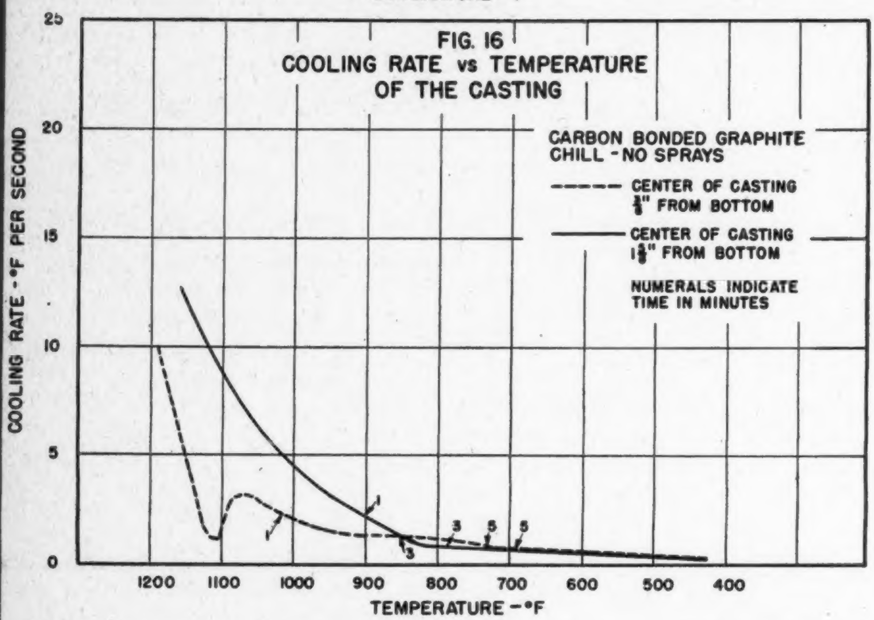


FIG. 16
COOLING RATE vs TEMPERATURE OF THE CASTING

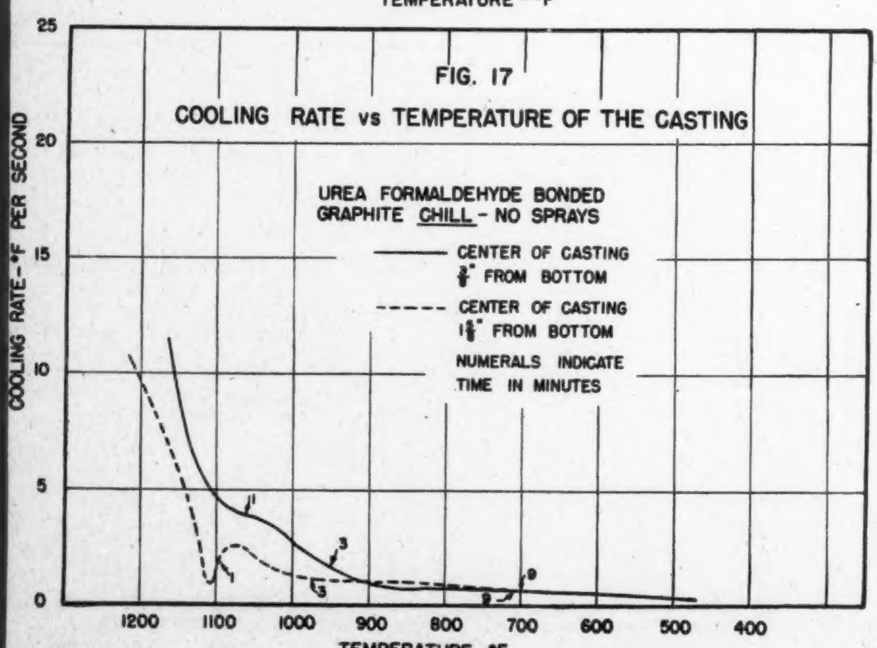


FIG. 17
COOLING RATE vs TEMPERATURE OF THE CASTING

alloys used in this country. Perhaps some small part of that range is most critical during solidification and feeding.

At present, it must be assumed that the whole range is important. The chilling capacity ratings of the mold materials discussed in this paper have been based upon their effectiveness throughout the solidification range of the ternary commercial magnesium-base alloys.

Chilling Capacity of Mold Materials. A comparison of the chilling capacity of the various mold and chill materials on the inadequately risered ¾-in. panel is provided by Table 7. Method *A* is based upon the average cooling rates of panels produced by the molds in °F./sec. during the interval the lower thermocouples were at 1000° F. Method *B* is based upon a comparison of the relative length of time for the panels cast in molds to cool to a temperature of 700° F. as measured at the lower thermocouples, the basis of comparison being green molding sand.

Chilling Capacities

Method *C*, on the other hand, is based upon the magnitude of thermal gradients produced by the various chill materials as the panels cooled from 1100 to 700° F., assuming green molding sand to be unity. The close agreement among these various arbitrary methods of evaluating chilling capacity indicates that these mold materials have chilling capacities in the order listed.

In any discussion of the factors influencing the chilling capacity of a material, at least three properties should be considered: (1) thermal conductivity, (2) specific heat, and (3) density. The product of the latter two physical properties forms a third value which, for the purpose of convenience in the remainder of this report, will be called "heat capacity."

An examination of the data summarized in Table 6 reveals that all materials with high chilling capacity have also high thermal conductivity, while the heat capacity, specific heat, and density vary over a relatively wide range. Therefore, if a material is to have a high chilling capacity it must have primarily a high thermal conductivity, and secondarily, a high heat capacity.

Foundry cores generally have a high heat capacity, but their thermal conductivity is low. The thermal conductivity of a core is a function of both the properties of the basic core material and its manner of agglomeration. Thus, steel shot, for example, has a high thermal conductivity in itself, but the method of joining the shot and sand* together through a point-to-point contact, which itself is insulated by the binder being used, reduces the thermal conductivity of the steel shot core to a low value.

When metal is cast against such a core the layer of sand grains and steel shot at the surface removes heat from the casting at a relatively high rate. However, as soon as the surface grains are in temperature equilibrium with the casting, which probably occurs almost instantaneously, the core can then absorb heat no faster than heat can be removed from the hot metal-core interface through the core.

Radiation

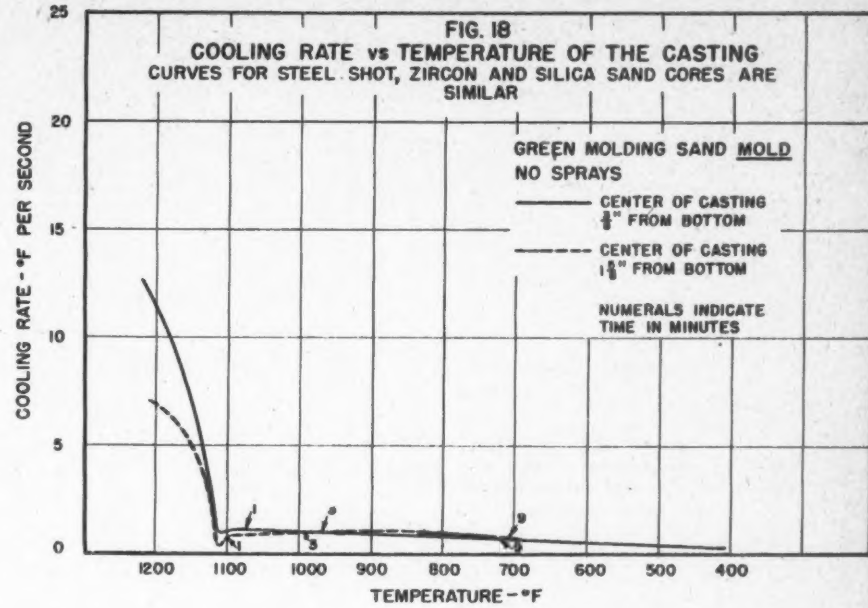
In the case of such cores heat transmission by conduction from grain to grain is slow, and possibly the greater part of the heat removal may occur by radiation[10] and by convection through the gases in the interstices surrounding the individual grains of which the core is composed. This accounts for the relatively low chilling capacity of steel shot and zircon core sands.

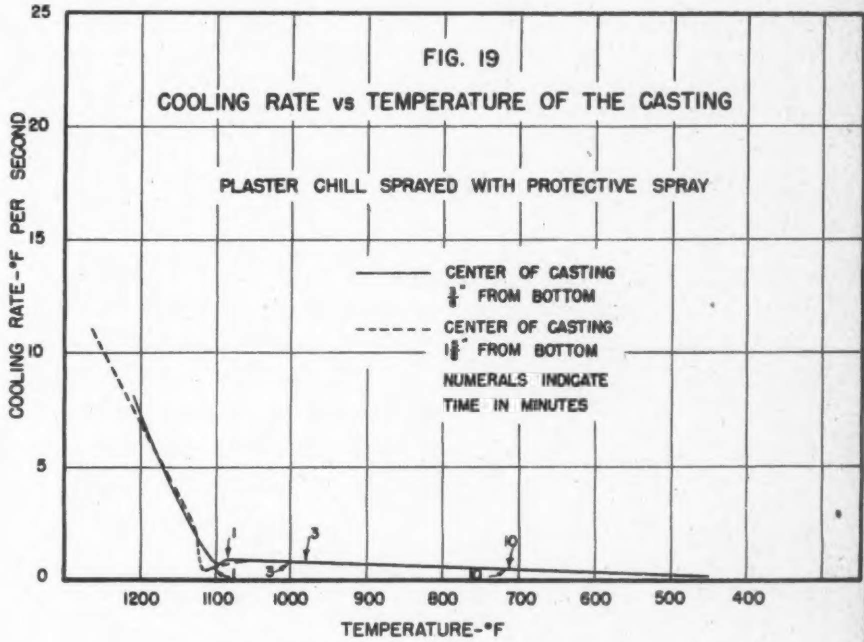
Graphite-base cores had a higher chilling capacity than did the sand-base cores, but the ratio of the chilling capacities was only of the order of 5 to 1. However, the ratio of the thermal conductivities of graphite and silica is of the order of 145 to 1.

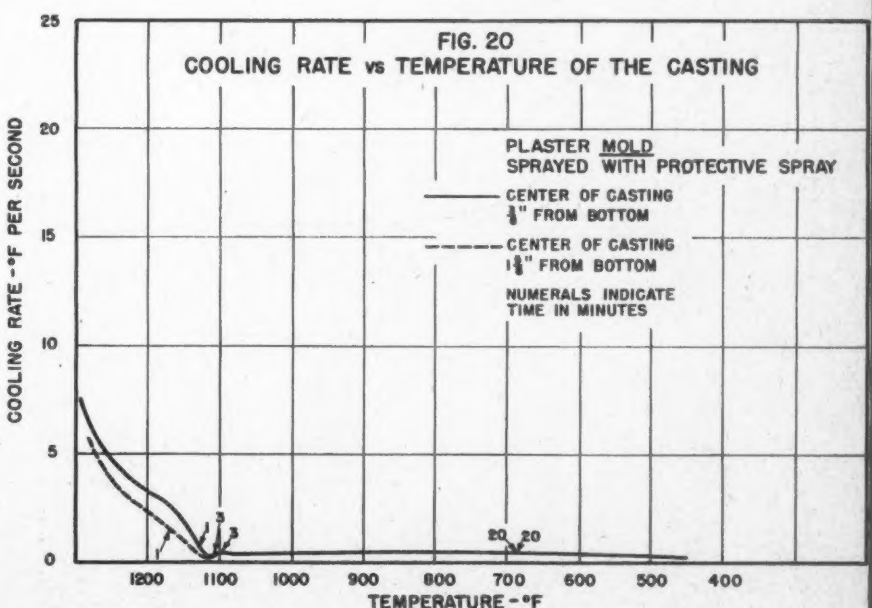
It is thus demonstrated that, although the increased thermal conductivity of the base material results in a small increase in chilling capacity, the main factors controlling thermal conduction in an agglomerate are the resistance to heat transfer offered by the binder and poor contact between the particles.

Use of Chill Spray. Castings poured against bare metal chills and molds which were heated and placed in the mold just prior to casting frequently exhibited blows.

*Thermal conductivity of a piece of silica is about 0.0025 cal/cm/cm²/°C/sec.







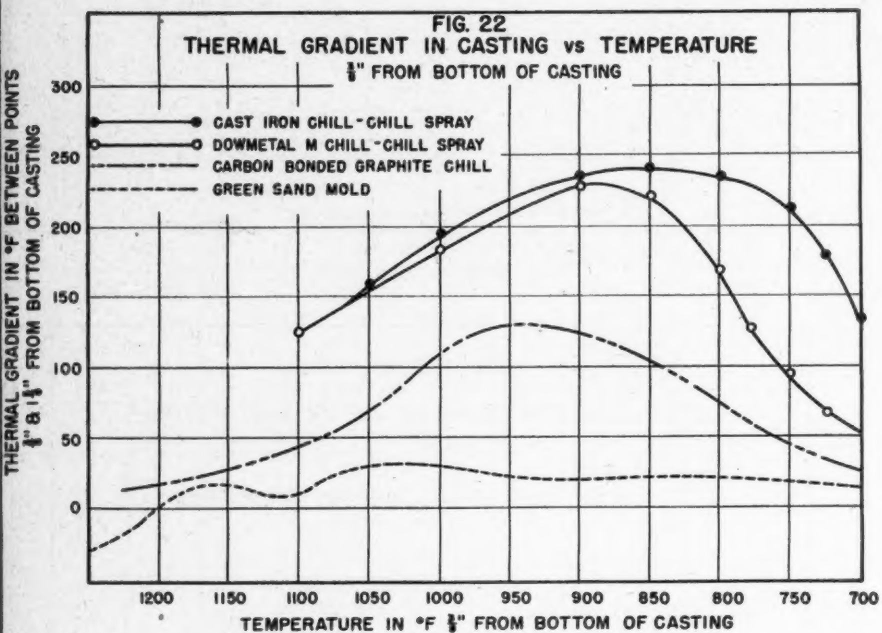


FIG. 22
THERMAL GRADIENT IN CASTING vs TEMPERATURE
⅛" FROM BOTTOM OF CASTING

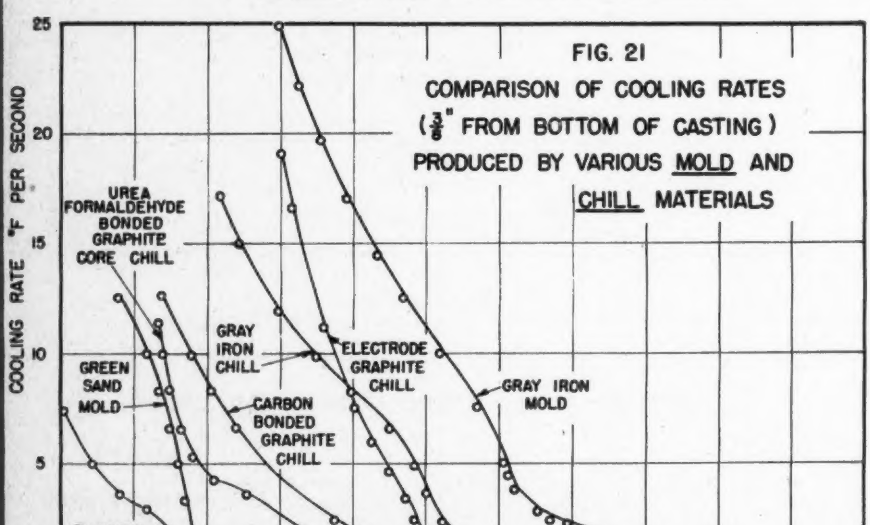


FIG. 21
COMPARISON OF COOLING RATES
(⅜" FROM BOTTOM OF CASTING)
PRODUCED BY VARIOUS MOLD AND CHILL MATERIALS

These blows locally insulated the casting from the mold or chill, thus reducing the chilling capacity rating of the uncoated chill and mold materials.

When chill and mold materials were coated with a chill spray the tendency toward formation of blows was eliminated. As may be seen from the summary of data, Fig. 4, chill spray had a slight insulating effect upon heat transfer to the chills and molds.

Effects of Thermal Gradients upon Properties. In addition to the effects of the mold and chill materials upon cooling rates and thermal gradients, it is desirable to relate the magnitude of those thermal conditions with the mechanical properties of the resulting castings, and also to demonstrate the importance of thermal gradients in securing sound castings.

Cooling Rates

In the mold tests a wide range of cooling rates was produced, while in the chill tests a wide range of thermal gradients was obtained. Castings made by both methods were sectioned for test bars, and subsequently broken in tension in the solution heat treated condition. By plotting the thermal gradient values of all castings against the ultimate tensile strength of the lower test bars, as in Fig. 24, a curve is produced which demonstrates the effectiveness of increasing thermal gradients on the properties and soundness of the panel.

Similarly, plotting the values for cooling rate at 1000° F. against the ultimate tensile strength of the lower test bars, as in Fig. 25, indicates a lack of correlation. For example, a cooling rate of 1° F./sec. may produce tensile properties ranging from 30,000 to 43,000 psi., and from an unsound to a sound casting. High cooling rates contribute to high tensile properties and casting soundness primarily through the promotion of adequate thermal gradients.

When the thermal gradient was greater than 98° F./in., both bars had better than typical properties (Table 8). When the thermal gradient was above 21° F./in., the properties of the casting were just above the specified minimum.

It must not be assumed that these values hold for all sections

Table 6

Relation of Mold Materials to Cooling Rates and Properties of Castings

Material	Density, gr/cc	Thermal Conductivity, cal/cm/cm²/° C/sec	Heat Capacity cal/cm³/° C	Spray	Cooling Rate at 1000° F., °F/sec	Thermal Gradient, °F/in.	Average Time to Reach 700° F., sec.	Mechanical Properties — Upper Test Bar — Elongation, % in 2 in.	Upper Test Bar — Yield Strength, psi.	Upper Test Bar — Tensile Strength, psi.	Lower Test Bar — Elongation, % in 2 in.	Lower Test Bar — Yield Strength, psi.	Lower Test Bar — Tensile Strength, psi.	Metallographic Properties H-HT — Massive Compound†	Porosity†	Grain Size, in.	Radiographic Rating*
Molds																	
Cast Iron	6.53	0.110	0.863	None	19.1	73	27	8.0	14,700	33,700	18.0	15,800	44,200	0	0.5	0.002	2
				Chill	13.5	92	28	13.7	15,200	39,200	16.9	15,600	42,800	1	1	0.002	1+
Mg "M" Alloy	1.76	0.310	0.438	None	13	55	50	9.5	15,700	36,900	14.8	15,500	42,700	1.5	3	0.002	1.5
				Chill	12	62	47	14.1	15,400	41,400	17.2	15,300	43,300	1	3	0.002	1.5
Electrode Graphite	1.55	0.347	0.302	None	17.5	72	29	12.9	15,100	39,700	17.6	15,400	43,000	1	2	0.002	2
Urea Formaldehyde Bonded Graphite Core				None	5	51	158	9.8	14,000	37,300	17.0	14,700	43,100	0	0	0.002	2
Zircon Core	2.27	7.91x10⁻⁴	0.422	Protective	1	21	452	8.5	13,700	33,800	11.1	14,700	38,600	2	3.5	0.003	4
Steel Shot Core	3.22	10.7x10⁻⁴	0.695	Protective	1.2	31	402	9.0	14,300	35,700	12.5	14,900	40,800	1	2.5	0.0025	3
Molding Sand	1.76			None	1	15	551	8.4	12,700	28,900	7.9	12,800	32,700	0	3.5	0.005	4
Silica Core	1.60	10.0x10⁻⁴	0.406	Protective	1	19	492	7.4	12,900	30,000	10.2	14,500	36,500	1.5	1	0.0035	4
Urea Formaldehyde Bonded Core	1.60		0.406	None	1	18	558	6.8	12,800	27,600	10.2	14,000	34,800	1.5	2	0.003	4
Plaster	0.62			Protective	0.5	6	1162	2.8	9,200	15,000	3.0	12,400	22,200	3	3.5	0.005	5
Chills																	
Cast Iron	7.43	0.110	0.980	None	7	171	72	15.9	14,500	41,700	17.9	15,700	43,600	0	2.5	0.0025	1
				Chill	4.7	144	116	16.0	14,400	41,500	16.4	15,100	42,200	1	2	0.002	1+
Mg "M" Alloy	1.76	0.310	0.438	None	4.7	120	225	15.3	13,900	41,500	15.1	15,400	42,100	0	1	0.002	1+
				Chill	4.4	117	253	15.1	14,200	40,800	16.4	14,900	42,600	0	2	0.002	1+
Electrode Graphite	1.635	0.347	0.319	None	4	129	286	14.7	14,600	41,500	14.8	15,700	42,200	0	2	0.002	1.5
Carbon-Bonded Graphite	1.70	12.95x10⁻³	0.427	None	2	58	300	11.6	13,100	38,200	16.1	14,300	42,600	0.5	1	0.002	2—
Urea Formaldehyde Bonded Graphite Core				None	1.3	42	398	14.3	13,300	40,700	15.7	14,800	43,400	0	0.5	0.002	2
Steel Shot Core	3.22	10.7x10⁻⁴	0.695	Protective	1	19	518	7.3	13,500	31,300	9.6	14,000	36,300	2.5	2.5	0.0035	3.5
Zircon Core	2.27	7.91x10⁻⁴	0.422	Protective	1	16	530	7.5	12,500	27,800	9.9	14,200	35,100	1.5	0.5	0.0025	4
Silica Core	1.60	10.0x10⁻⁴	0.406	Protective	1	15	574	6.9	13,400	29,900	8.0	14,200	33,200	2.5	3	0.003	3.5
Urea Formaldehyde Bonded Core	1.60	10.0x10⁻⁴	0.406	None	1	12	544	7.5	12,500	30,500	9.5	13,300	34,600	1.5	3	0.0035	4+
Plaster	0.64			Protective	0.8	10	632	5.7	12,400	29,800	5.5	13,300	30,400	3	4	0.003	4
Mold Material	*Panel Size, in.*	*Riser Size*	*Degassed*	*Pouring Temp., °F.*													
Molding Sand	¾	Small	No	1450	1	15.0	551	8.4	12,700	28,900	7.9	12,800	32,700	0.0	3.5	0.005	4.0
Molding Sand	¾	Small	Yes	1450	0.7	15.2	570	11.3	12,100	34,200	13.5	13,200	39,100	1.0	2.5	0.007	2.2
Molding Sand	¾	Large	Yes	1400	0.6	24.7	758	13.2	13,000	38,400	12.8	13,500	38,600	1.5	1.0	0.006	1.2
Molding Sand	¾	Large	Yes	1450	0.5	24.7	739	12.5	12,300	37,500	14.0	12,900	38,800	1.5	2.0	0.006	1.2
Molding Sand	¾	Large	Yes	1500	0.5	24.0	940	12.8	13,100	38,300	15.0	13,500	40,500	1.0	0.6	0.007	1.5
Molding Sand	¾	Large	No	1450	0.6	22.3	800	7.0	11,800	29,300	13.5	13,000	37,600	1.5	1.0	0.006	2.2
Molding Sand	⅜	Small	Yes	1400	2.0	32.0	215	12.7	13,100	38,700	14.8	13,900	40,500	0.5	1.5	0.004	2.7
Molding Sand	⅜	Small	Yes	1450	2.0	31.1	226	14.7	13,800	40,700	14.2	14,100	41,100	0.0	2.0	0.004	4.0
Molding Sand	⅜	Small	Yes	1500	1.6	32.8	321	11.8	13,600	38,300	16.0	14,000	41,300	0.5	2.5	0.004	3.0
Molding Sand	⅜	Small	No	1450	2.5	30.4	240	11.5	13,500	37,300	14.5	13,900	41,300	0.0	3.0	0.004	4.0

* An arbitrary numerical rating in which the value of 1 is assigned to a radiographically sound panel and a value of 5 to the panels with minimum soundness.
† See reference No. 17 in bibliography.

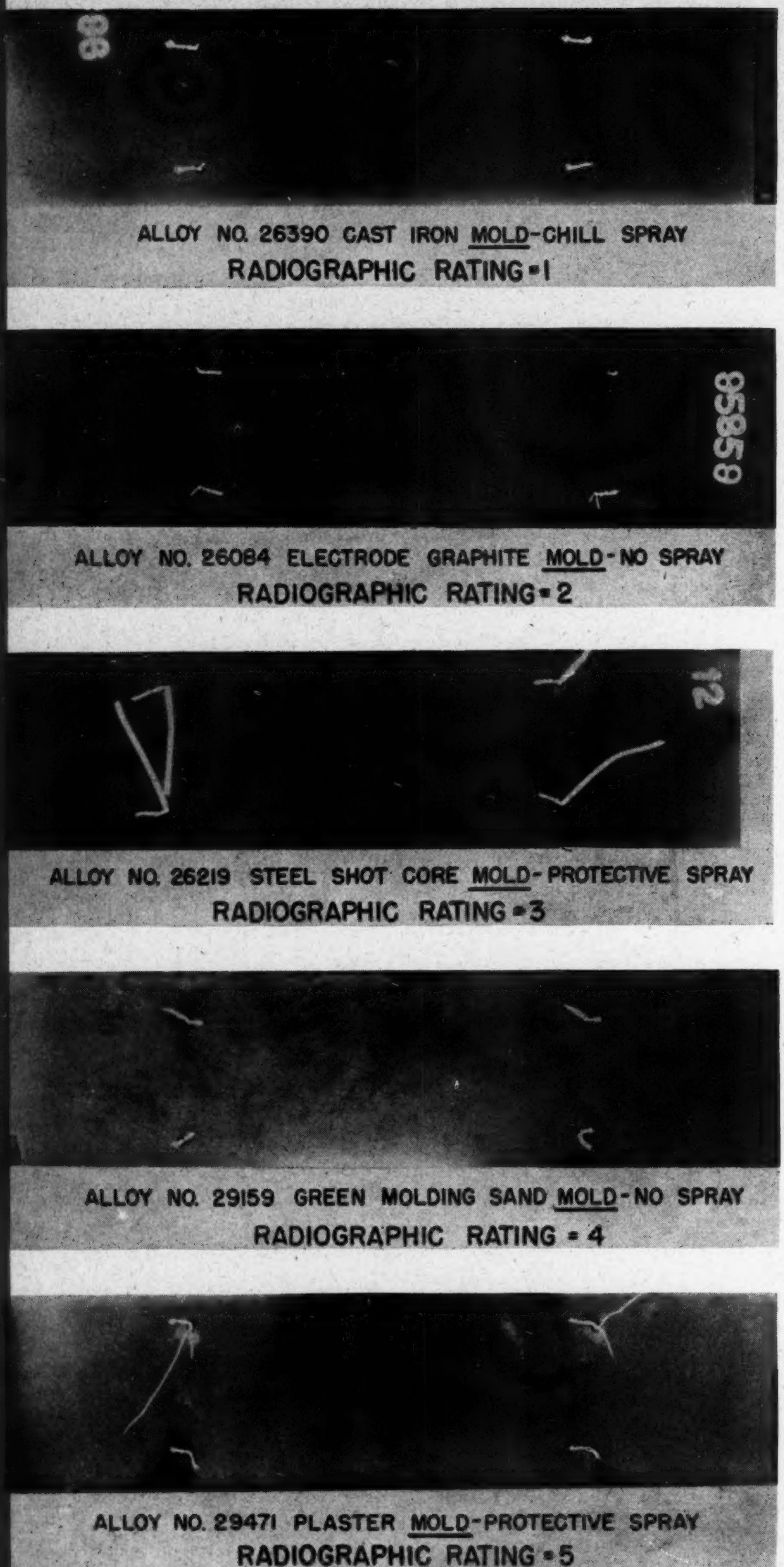


Fig. 23—Representative radiographs of magnesium "H" alloy panels cast in molds of various types. Demonstrating the rating system.

of all castings, for they relate only to the casting studied in this work or similar sections acted upon by the same thermal and feeding conditions. For each set of thermal and feeding conditions there is undoubtedly a minimum thermal gradient which will produce a sound section.

Effect of Degassing the Metal. All tests discussed thus far were performed using metal prepared according to normal commercial practice except that no final degassing treatment was applied. Additional tests were made with the green sand mold using metal that was degassed with chlorine. The ultimate tensile strength of the casting made in this manner was improved 20 per cent over the unchlorinated condition, which raised it well above the specified minimum value without improving the thermal gradient.

Riser Inadequate

It must be remembered that in the green sand mold the riser was designed to be inadequate. Assuming that gas is present in the molten metal in quantities greater than the solubility value at the freezing point, we may conclude from the data presented in Table 6 that the effectiveness of dissolved gas in causing gas porosity is greatest under those conditions where the riser is inadequate.

Continuing our views on gas porosity, it is presumed that in the process of metal solidification, shrinkage of the solidifying casting demands either the formation of a void, a collapse of the casting wall, or the feeding of liquid metal. As the temperature of the riser decreases, liquid metal from the riser feeds at a diminishing rate to the casting, but demands of the solidifying casting for "feed" continue undiminished.

In the case of an inadequate riser a stage is reached in which the "feeding pressure" on the shrinking mass, which is the summation of all pressures contributing to feeding, is reduced below the vapor pressure of the dissolved gas. To satisfy its vapor pressure the gas precipitates out of liquid solution, causing porosity.

In a casting solidifying similarly, but with more pronounced thermal gradients, the riser becomes more effective as a feeder. Adequate feeding pressure is maintained for a

longer period of time so that the stage of gas interference with feeding described in the foregoing is delayed, thus reducing or even eliminating its effect.

Use of a Larger Riser for More Adequate Feeding. The reduced significance of dissolved gas on microporosity when the feeding is more adequate is shown in a series of tests performed using the same experimental conditions as before except for an enlarged riser. Castings were made from both chlorinated and unchlorinated metal.

For castings with enlarged risers made from unchlorinated metal the thermal gradient was increased by 65 per cent over that of the original panel, while the ultimate tensile strength was increased by 15 per cent. This demonstrates the normal result of improving the feeding conditions.

Degassing Beneficial

On the other hand, degassing the metal increased the ultimate tensile strength by 4 per cent over that of metal not degassed. Evidently, improved thermal conditions and a more adequate supply of feed metal reduced the deleterious effect of the dissolved gas.

Thin Panel Casting. In order to obtain some idea of the comparative thermal conditions and casting quality attainable by use of a casting and riser of different size, both the panel and riser thicknesses were reduced by 50 per cent, the other dimensions remaining the same. This change did not alter the riser: casting size ratio as used in the original test.

Again the casting was made in a green sand mold. The reduction in casting and riser thicknesses resulted in a doubling of the thermal gradient. The ultimate tensile strength of the thin casting was 26 per cent greater than that of the thick casting.

In additional tests with the thin casting, degassing the metal by chlorination produced no further improvement in the ultimate tensile strength.

Data for these feeding studies may be summarized as shown in Table 9.

Effect of Pouring Temperatures. For the special panels, namely, that with the enlarged riser and the thin panel, castings were poured at tem-

Table 7

COMPARISON OF CHILLING CAPACITIES OF VARIOUS MOLD AND CHILL MATERIALS

Mold Material	Chilling Capacity — Molds: Method A[1] (°F/sec)	Molds: Method B[2]	Chills: Method C[3]
Cast iron	19	20	20
Electrode graphite	18	19	16
Magnesium "M" alloy	13	11	14
Carbon-bonded graphite*	—	—	7
Urea formaldehyde-bonded graphite	5	4	5
Oil-bonded steel shot core sand	1.2	1.4	1.5
Oil-bonded zircon sand	1.0	1.2	1.0
Fluoride type molding sand	1.0	1.0	1.0
Urea formaldehyde-bonded silica sand	1.0	1.0	0.7
Plaster	0.5	0.5	0.5

*This material was not available in sizes large enough to be used as a mold.

[1]Based on cooling rate at 1000° F.

[2]Based on reciprocal of time for casting to cool to 700° F., assuming the value of green molding sand to be 1.0.

[3]Based upon the comparable thermal gradients in ° F./in., again assuming the value of green molding sand to be 1.0.

Table 8

TENSION TEST BAR PROPERTIES

(Solution heat treated Mg "H" alloy)

	Ultimate Strength, psi.	Yield Strength, psi.	Elongation, % in 2 in.
Typical Properties	40,000	14,000	12
Specified Minimum	34,000	10,000	7

Table 9

INFLUENCE OF IMPROVED FEEDING UPON PROPERTIES

	Panel Size, in.	Thermal Gradient, °F./in.	Improvement in Ultimate Tensile Strength over Basic Test, %
Basic test (panel cast in green sand mold; metal not degassed)	¾	15.0	0
Metal degassed with chlorine	¾	13.8	20
Riser enlarged; metal not degassed	¾	20.3	15
Riser enlarged; metal degassed with chlorine	¾	22.5	19
Same casting; riser size ratio as in basic test; metal not degassed	⅜	27.6	26
Metal degassed with chlorine	⅜	28.3	26

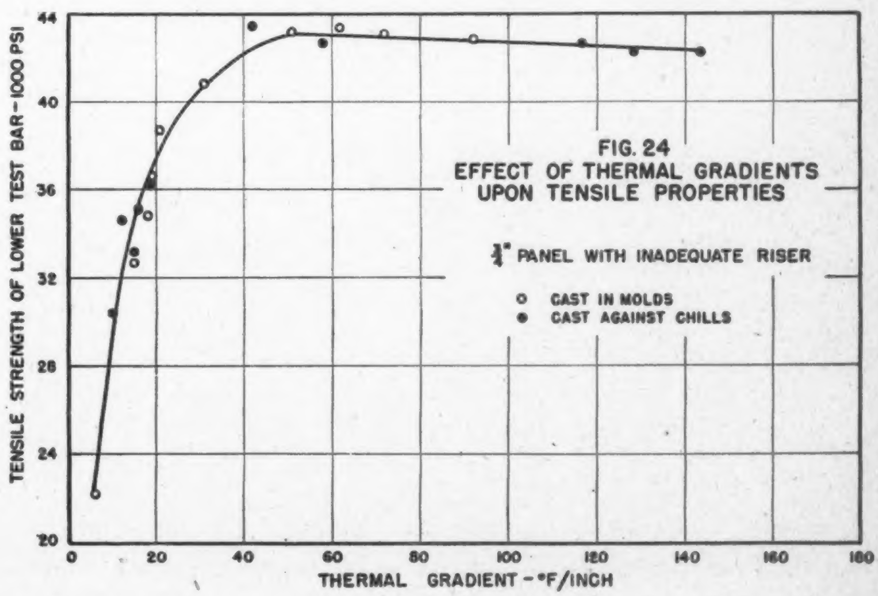
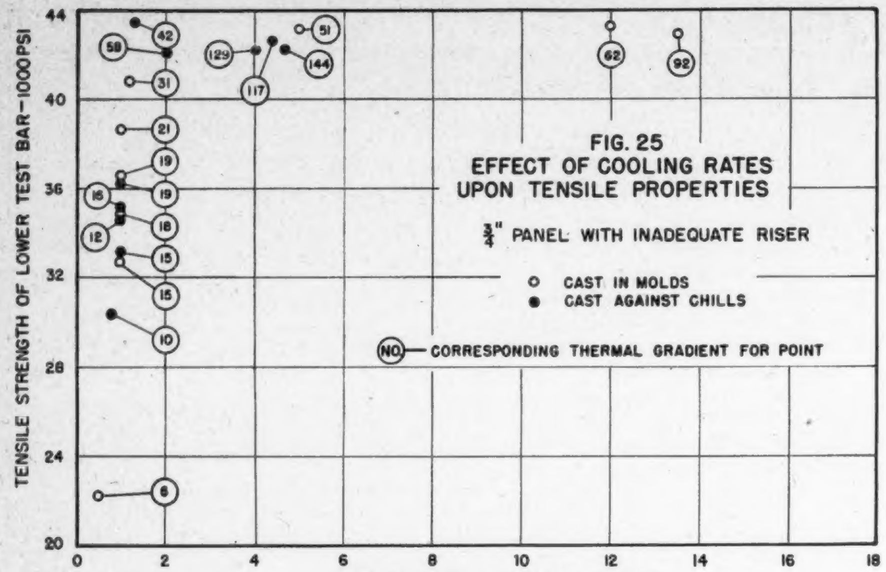


FIG. 24
EFFECT OF THERMAL GRADIENTS UPON TENSILE PROPERTIES



peratures of 1400° F., 1450° F., and 1500° F., using degassed metal. The ultimate tensile strength was improved slightly by increasing the pouring temperature. There was no noticeable effect upon the thermal gradient; however, the time required for the casting to cool to 700° F. correlated with the casting temperature. Increases in pouring temperature produced longer cooling times.

Cooling and Cooling-Rate Curves. Both the cooling and cooling-rate curves display some interesting phenomena. For the slowly cooled panels the cooling curves show a retardation at about 1100° F. The corresponding cooling-rate curves show arrests in the cooling rate at the same temperature.

These retardations and arrests indicate sudden decreases in the cooling rates of the panels at 1100° F. Starting about this temperature (the liquidus temperature) the latent heat of fusion of the metal is released as the casting solidifies. This release of heat continues until the casting is entirely solid, so that the cooling rate of the casting is retarded in the entire solidification range. Curves for the slowly cooled panels do not show any marked change in cooling rate around 700° F. (the solidus temperature). Undoubtedly some change in cooling rate occurs, but the temperature readings in this range were taken at too great intervals to show the effect.

For swiftly cooled panels the cooling-rate curves show definite retardations or arrests in the range between 1100 and 700° F. The arrests at 1100° F. are considered to be similar to those previously described for the slowly cooled panels.

Arrests observed at lower temperatures are thought to be caused primarily by (*a*) release of heat of fusion in the riser as it begins to solidify, and to minor extents by (*b*) release of heat of fusion of low melting point eutectic mixtures formed in large amounts by a shifting of the areas of the equilibrium diagram to the left during rapid solidification, and (*c*) undercooling. It is to be noted that the more rapid the cooling rate the lower the temperature at which the arrests occur.

Conclusions

1. Chilling capacity of a mold material depends directly upon its thermal conductivity and its heat capacity. Since the thermal conductivity of mold materials may range from 0.001 to 0.350 cal/cm/cm²/°C/sec. (350 to 1) whereas heat capacity varies from 0.300 to 0.980 cal/cm³/°C (3 to 1), it follows that changes in heat conductivity will exert normally a greater influence on chill capacity than changes in heat capacity.

2. Chilling capacity of a heterogeneous mold is particularly sensitive to the intergranular area of contact and to the thermal conductivity of the film separating the grains.

3. Use of steel shot core sand, or of zircon core sand, provides slightly greater chilling capacity than does silica sand, but this increase is deemed insufficient to justify their use for the production of magnesium castings.

4. High cooling rates contribute to high tensile properties and casting soundness primarily through the promotion of adequate thermal gradients.

5. Dissolved gas is detrimental to casting soundness when feed metal or feeding pressure is inadequate.

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Occupancy of its new building at 575 E. Milwaukee St., Detroit, has been announced by **William F. McGraw & Co.**

ASSOCIATION JOINS
Chapter in Sponsoring Museum Exhibit

ADDITIONAL THOUSANDS of students and adults will become acquainted with the foundry industry and acquire an increasingly favorable impression of the opportunities it offers young men, as a result of recent action by A.F.A. in assuming co-sponsorship, with its Chicago chapter, of the operating foundry exhibit at the Museum of Science and Industry, Chicago.

Immediate result of the move, taken in view of the national character of the Museum's attendance, and as an activity of the National Educational Program, was resumption of molding and pouring exhibitions in the foundry on a five-day-week basis. Since the end of the war, demonstrations had been limited to two days a week. However, the Association's financial assistance makes it possible to expand operations to a five-day period.

Attendance records for the castings exhibit show a marked upswing when the foundry is operated on a five-day week, with a more than 70 per cent increase in the number of visitors as compared with periods when castings are poured only two days a week. More than 120,000 people inspected the Museum's foundry annually during the war years, when it was engaged five days a week in war production of castings.

Attendance High

With 1946 expected to break all records for attendance at the institution, visited by more than one million from all over the country during each of the last two years, it is estimated that nearly 200,000 people will view the foundry exhibit this year. They will see pouring-molding operations performed under a clean and efficient set-up by men in pleasant and comfortable surroundings.

Accompanying the operations, a demonstrator presents a discussion of basic aspects of foundry technology and methods, which adds to the value of the exhibit by giving the public a general understanding of steps in production of castings. A.F.A. has the privilege of suggesting revisions in operating procedure of the Museum foundry and in the script used by announcers, where necessary to present the message of the foundry industry in the most advantageous manner.

Significantly, the message conveyed by this exhibit reaches an audience, according to Museum figures, in which the largest occupational group is students; the second largest, housewives. The latter group, of course, includes mothers of young men who, in many cases, have yet to decide upon a career.

Approximately 22 per cent of the visitors are students of high school or college age; and it is reported

(Continued on Page 49)

Interested spectators watch foundry operators pour metal at the Museum of Science and Industry, Chicago.

ELECTRODES CARBON AND GRAPHITE

ACID ELECTRIC PRACTICE

T. L. Nelson
National Carbon Co.
New York

CARBON IS AN ELEMENT possessing many interesting and valuable properties. Pure carbon is known in forms varying from the diamond (white, transparent, and extremely hard) to graphite (black, opaque, and very soft). Impure carbon is found in abundance in all parts of the world in such natural forms as anthracite and bituminous coals, and as natural graphites; in such industrial by-products as petroleum and pitch cokes, coal tar pitch and foundry cokes; or in such manufactured products as lampblack, gas black carbon, charcoal, and graphites.

The use of carbon in the electrical industries had its start in the work of Sir Humphrey Davy who, in 1800, produced an electric arc between ¼-in. diameter carbon electrodes. These electrodes were composed of powdered wood charcoal and syrup of tar molded to shape under a pressure of 100 lb. per sq. in. Davy may be credited, therefore, as the one who originated the carbon industry as well as the basic industrial and commercial application of carbon products made possible through further research and the development of mechanically generated electric power.

Davy's use of carbon electrodes was not the result of a stroke of luck, but rather was based upon a recognition of the relation of his furnace's requirements to the fundamental properties of carbon. First of all, he recognized the carbon electrode not as a raw material for his process but rather as a terminal conductor for the electric current to his furnace.

This principle holds true today in the modern electric steel furnace. The first purpose of the electrode, whether carbon or graphite, is to conduct the electric current to that place in the furnace where the electrical energy is to be changed to heat energy. This change takes place at the arc end and is the fundamental essential for the generation of high temperatures for the production of such high-temperature products as electric steel.

Good Conductors

Carbon and graphite electrodes are good conductors of the electric current, but certain metals such as iron and copper are much better conductors because of their lower electrical resistance. Why, then, should carbon be selected for this task?

Carbon holds an important place among the basic raw materials essential to our present industrialized world. It is essential to the generation and application of power; it has made possible modern alloy steels, many metallurgical products and nonferrous alloys, and the development of the motion picture industry. In fact, carbon touches our daily lives in so many different ways that few realize their dependence upon this many-sided element.

Everyone knows that if sufficient electric current be passed through steel or copper wires, they will soon reach temperatures at which they will melt. This property of melting at relatively low temperatures eliminates these metals as terminal conductors in an electric steel furnace. Carbon does not melt at any known temperature but rather sublimes or volatilizes in the arc.

No other known substance approaches carbon in this property. The choice of carbon as the terminal conductor in the electric furnace is, therefore, fundamentally sound.

Because of its infusibility at the temperature of the electric arc or at any known temperature and because of its property of electrical conductivity, carbon possesses that characteristic which permits the change of electrical energy into heat energy at the arc to produce a temperature of approximately 6870° F., the highest temperature yet produced by artificial means. Thus the heat energy is set free at a stable point where it can do the most useful work.

Carbon possesses also a thermal conductivity that is high in comparison with most non-metallic solids, and this property in combination with low thermal expansion gives to this element high resistance to heat shock.

At the highest temperature possible of attainment, carbon or graphite have been known to soften but never to melt. Since they cannot be fused, liquefied, or forged like iron, steel or copper, carbon electrodes must be produced by dif-

ferent methods than are common to metallurgy.

In electrode manufacture, carbon raw materials are calcined and then formed by hydraulic pressure. A sintering treatment known as "baking" follows, after which thousands of amperes of current are passed through the electrodes until the temperature reached is approximately 5000° F. This produces the crystal form of carbon known as graphite, which can then be heated and reheated to any temperature attainable by artificial means without a change in its structure, or a melting of its mass.

The end result of these operations is a manufactured carbon product which, through its properties of high electrical conductivity, infusibility, low thermal expansion, high resistance to heat shock, low rate of oxidation and ability to produce an electric arc carrying the highest temperature yet produced by artificial means, makes it an ideal electrode material. No material other than carbon possesses the unique combinations of physical, chemical and electrical properties required of electrodes in the modern arc type of electric furnace.

Methods of Manufacture

The unit processes employed in the manufacture of carbon and graphite are:

- Selection of raw materials,
- Calcination,
- Sizing,
- Mixing,
- Forming,
- Baking,
- Graphitizing,
- Machining.

Raw materials used in the manufacture of carbon electrodes are: anthracite coal, coke, and coal tar pitch. For graphite electrodes the raw materials are petroleum coke and coal tar pitch. Each raw material is carefully selected for certain characteristics that it must impart to the finished electrode, and must, therefore, pass rigid laboratory tests. The physical differences in raw materials affect the appearance of the two types of electrodes, the carbon electrodes being characterized by the presence of anthracite coal particles, while the graphite electrodes appear uniform in structure and composition throughout the entire mass.

The processes for making the two kinds of electrodes are similar in general but differ in certain particulars. Anthracite coal and coke are calcined at high temperatures by electrical methods, after which they are crushed, screened and milled to the required size for the size of electrode to be made. Petroleum coke for graphite electrode manufacture, on the other hand, is calcined to a low final temperature by the combustion of fuel oil.

Mixing Ingredients

Dry ingredients of the proper proportions are then weighed into heated mixers and are allowed to mix for a fixed period of time in order to melt the pitch and uniformly blend it throughout the mass. This well-mixed material is then moved to the hydraulic press where, by means of the proper die, it is extruded into the required shape and size.

At this stage the formed product, referred to as the "green" electrode, is allowed to cool, after which it is carefully inspected for appearance shape, size, freedom from cracks and other defects, and then forwarded to the baking department. The purpose of baking is to coke the pitch bond and give to the electrode permanency and perfection of form, high mechanical strength, thermal conductivity, and low electrical resistance.

Ovens are of the gas-fired type and consist of a bank of cells surrounded by the heating passages or flues. The green electrodes are placed in cells and surrounded by packing coke or sand, which holds them in shape during the softening period of the baking operation. Heat is directed through the flues and the cell is allowed to heat at a given schedule, depending upon the electrode grade and size.

Final baking temperature varies from 1560 to 1830° F., after which cooling and unpacking follow in natural order. The complete cycle of loading, baking, cooling and unpacking takes from 35 to 45 days, depending upon the electrode size and the time of year.

After unpacking, the baked electrodes are cleaned of packing material and are then carefully inspected for form, curvature, dimensions, cracks, surface defects, density and specific resistance. In the case of carbon electrodes, the baked product at this point is threaded on self-centering double-end lathes and is ready for use.

Gas-baked petroleum-coke electrodes must be graphitized before they can be used in steel furances —an operation carried out in horizontal resistance furnaces. The electrodes are loaded and packed in each furnace, each electrode being separated by resistor coke.

The whole mass is covered by coke and insulating mix, after which power is turned on and heat generated for a given period of time. Heating of the mass occurs because of its resistance to current flow, and the temperature finally reached is approximately 5000° F.

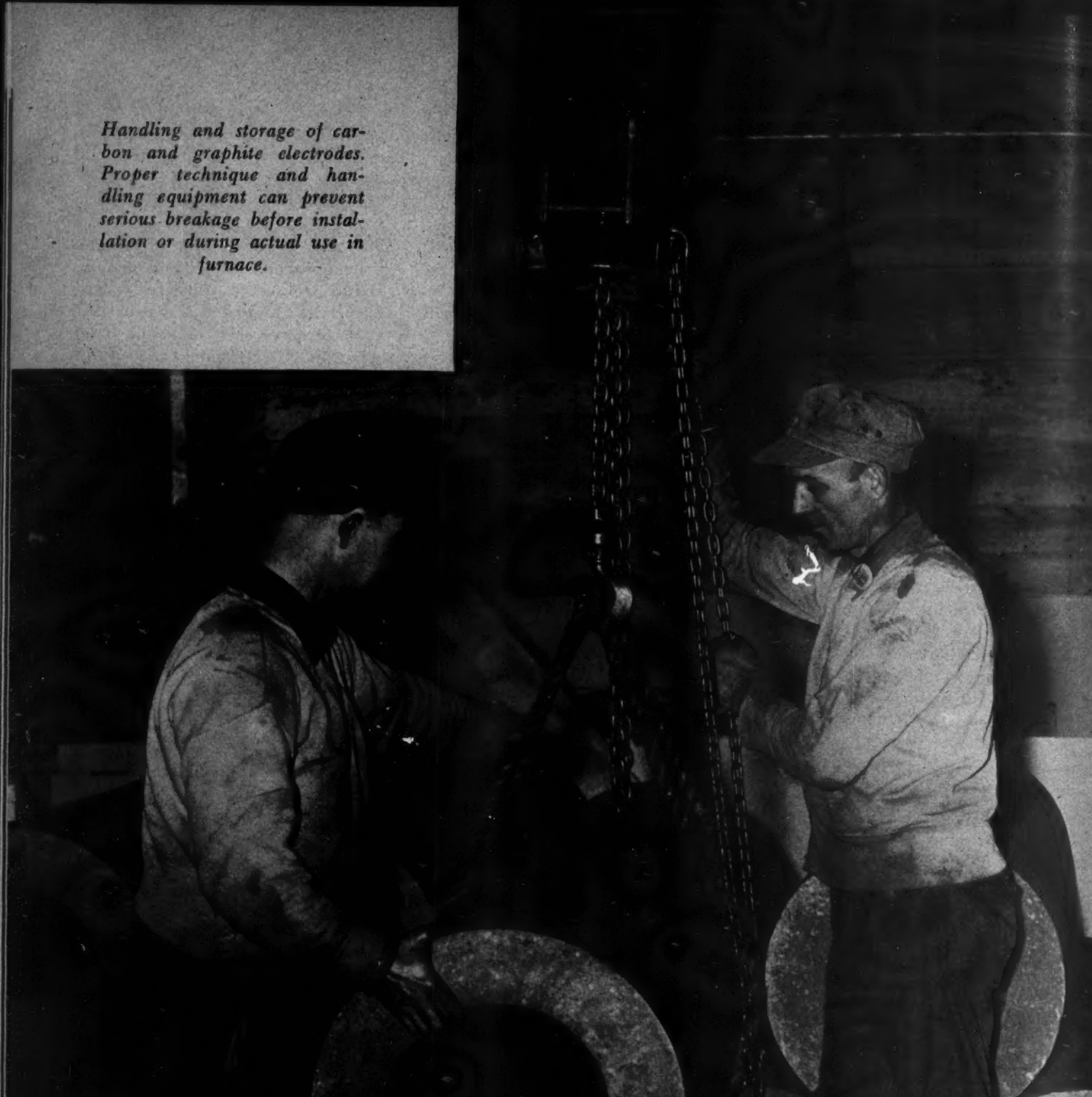
Cooling and unpacking follow, after which each graphitized electrode is carefully cleaned and inspected according to certain rigid product specifications. All round graphite electrodes are threaded on both ends—a final operation carried out on an automatic lathe of a specially designed type.

Comparative Nature and Properties

A *graphite* electrode is a mass of graphite of the desired shape and size, possessing a certain porosity of structure but containing no non-graphitic carbon. Coarse particles, flour, and bond carbon have been completely graphitized and are uniform as regards composition.

A *carbon* electrode, on the other hand, is a mass of highly calcined anthracite coal and petroleum coke, and a pitch coke resulting from the baking of the pitch bond at a lower temperature in the baking process. The three carbon materials in carbon electrodes therefore differ in physical and chemical properties, and the resulting electrode may be said to lack the uniformity in composition possessed by the graphite electrode.

In considering the physical and chemical properties of carbon and graphite electrodes, it should be emphasized that in any processes such as those used for the manufacture of these electrodes, in which a batch of solids is combined, the properties of the final product do not have the same uniformity as materials produced by the processes of solution, fusion, or crystallization. Electrodes, therefore, are one of the few products produced



Handling and storage of carbon and graphite electrodes. Proper technique and handling equipment can prevent serious breakage before installation or during actual use in furnace.

by technically controlled processes whose quality cannot be completely predetermined in the laboratory.

The manufacturer makes no claims for the absolute uniformity of his electrode, but rather places emphasis on the requirement that the product shall be maintained within certain established minimum and maximum limits. Such requirements are met through selection of raw materials and careful technical supervision and control of each step in the process of manufacture.

Certain physical and chemical properties indicate conformity to established limits, and experience has shown that when these properties are related to process control the result is an electrode which possesses:

Low consumption.

Freedom from spalling and cracking.

High mechanical strength and current carrying capacity.

Trueness of form and uniformity of dimensions.

Freedom from structural flaws.

Comparison of Properties

Certain average physical properties represent the differences that exist between carbon and graphite electrodes. They indicate that the graphite electrode has about one-fourth the resistance of the carbon electrode, and that the actual value varies slightly depending upon the size under consideration. On the other hand, the average apparent density of the graphite electrode is practically the same as that of the carbon electrode, which means that, with the higher specific gravity of the graphite electrode, its porosity is about 5 to 8 per cent higher.

Other physical properties such as tensile, compressive, and transverse strengths show a decided superiority for the graphite electrode. Thermal conductivity of the graphite electrode is approximately 12 times higher than that of the carbon electrode, and this fact must be taken into consideration in choosing the proper electrode for certain types of furnace installations.

Purity of graphite electrodes averages approximately 99 per cent. The actual amount of ash in this type of electrode varies from 0.04 to 1.5 per cent, but the average ash content is about one per cent and is composed generally of silicon carbide and the refractory carbides of silicon, iron, aluminum, calcium and magnesium.

Purity of the carbon electrode is somewhat lower and averages approximately 92 per cent. Composition of the ash of this electrode is largely made up of oxides of silicon, aluminum, calcium, magnesium, and carbides of iron.

Both Electrodes Oxidize

When carbon or graphite electrodes are heated to high temperatures in the presence of air they oxidize, which means that the oxygen in the air combines chemically with the carbon to form either carbon monoxide or dioxide gases. This reaction is at the expense of the carbon forming the electrode and, under normal operating conditions, accounts for approximately one-half to three-fourths of the life of the electrode, the remainder being consumed in the electric arc in carrying the current to the charge.

Since oxidation is such a predominant factor in rate of electrode consumption, it is obvious that everything possible should be done by the furnace operator to guard against unwarranted oxidation conditions.

Size. The electric furnace operator is often concerned with the problem of determining the proper diameter of electrode for a given installation. Sometimes it is a question of making a recommendation for a new furnace; at other times it is one of improving the general performance of an old furnace, frequently in connection with some change, made or contemplated, in operating procedure.

While the transformer rating and the diameter and capacity of the furnace proper are customarily the primary factors governing the decision, a number of other points must be taken into account, so that as a rule each case must be given individual consideration.

Points for Larger Diameter

In any particular instance where there is a reasonable choice, other things being equal, the advantages favoring a larger diameter electrode are these:

1. Lower electrical resistance permits an increased power input, increasing the rate of production.

2. Greater cross-sectional area of the column tips results in better distribution of the heat over the hearth, allowing a faster rate of input without overheating directly beneath the columns and promoting greater uniformity of temperature within the furnace, especially of the slag, which are quite important considerations metallurgically.

3. Greater cross-sectional area retards the rate of boring down through the initial charge, so that as the columns approach the bottom of the furnace there is a greater likelihood of an adequate pool of metal accumulating and consequently less danger of burning.

4. The larger diameter electrode is obviously more resistant to mechanical stresses.

5. Slower linear consumption per ton of product means less frequent joint assembly, saving a certain amount of time and labor.

6. Greater cross-sectional area results in a lower percentage of power loss due to resistance heating.

7. With a given power input there is a lower transverse temperature gradient built up in the column due to resistance heating, which may be a critical factor in the occurrence of electrode cracking where current densities are high.

Reasons for Smaller Diameter

On the other hand, the factors favoring a smaller diameter electrode are these:

1. Smaller surface area exposed decreases the percentage loss due to oxidation.

2. Decreased loss due to oxidation (smaller taper) results in a higher ratio of effective (tip) to nominal diameter, and also a relatively thicker socket wall as a joint approaches the tip.

3. Smaller cross-sectional area of the smaller electrode diameter makes it less subject to thermal shock both in the body and at the tip, and consequently it is less liable to cracking and spalling.

4. Less heat loss due to thermal conductance because of the smaller cross-section.

5. The arcs are further from the furnace side walls because of the smaller diameter at the column tips, so the refractories run somewhat cooler and have a longer life.

6. Smaller diameter roof ports required afford a mechanically stronger, longer-life roof, qualified to some extent by the lesser shielding effect of the columns.

7. Individual stub losses are smaller, although the aggregate sav-

ing is reduced by their somewhat greater frequency.

8. More sensitive power regulation, with its attendant advantages, is possible because of the lower inertia of the electrode columns.

9. The smaller weight of the electrode columns should result in decreased costs for repair and maintenance of the superstructure, cables and winches.

10. Electrode handling is facilitated by the lighter unit weight, and lighter connecting pins, lift plugs, hooks, etc.

11. Because of the lower unit cost, accidental breakage either on or off the furnace is less expensive.

Thus it can be seen that a recommendation of proper electrode diameter should be given considerable thought. Summarizing briefly, it may be said that, in general, the smallest diameter should be used that will permit the maximum rate of production without excessive electrode consumption, due either to overheating (oxidation) or breakage. Obviously, such a rule can only be applied on the basis of either comparative trials or experience under similar conditions at another plant.

Carbon Versus Graphite

Another problem frequently encountered, similar in many respects to that of determining optimum electrode diameter, is the choice between the two kinds of electrodes, carbon and graphite. Here too, many variables are involved.

Practical operating experience over a long period of time has indicated that because of the differences in properties (principally electrical conductivity and susceptibility to oxidation) a given graphite electrode is, as a general rule, approximately equivalent to a carbon electrode of twice the cross-sectional area. For this reason a logical comparison of the two kinds is one of a smaller graphite electrode versus a larger carbon electrode.

In favor of the smaller graphite electrode are, first of all, certain of the advantages previously discussed which result primarily because of the smaller diameter. These are:

1. Less exposure to oxidation.

2. Greater resistance to thermal shock.

3. Less danger of overheating side-wall refractories.

4. Smaller roof ports are required.

5. Less inertia to be overcome in power regulation.

6. Less weight to be supported by the superstructure.

7. Easier handling because of the lighter unit weight.

Graphite Advantages

Additional advantages due to the nature of the material are:

8. Stronger, lower-resistance, easier-assembled joints, because of the greater machinability of graphite.

9. No joint compound is required, since closer clearances and tolerances are obtained.

10. Greater resistance to oxidation.

11. Lower rate of consumption in lb. per ton of metal produced. Graphite consumption is only 50-75 per cent of the rate for carbon, depending on the particular conditions involved.

12. Lower power loss due to resistance heating. The electrical conductivity of graphite is approximately four times that of carbon, so that a graphite electrode of half the carbon cross-sectional area still will have twice the conductivity.

13. Since machinability of graphite makes it feasible to turn these electrodes, closer roof gland fits can be provided without difficulty due to deviations from form, such as diameter variation, ellipticity and curvature.

14. Better electrical contact is obtained in the holders because of the compressibility of graphite and the fact that these electrodes are turned, resulting in a decidedly longer holder life, with lower maintenance costs and less frequent delays for repairs.

15. Less tapering.

16. With the smaller and better joints, the joint fragments dropped in the bath tend to be of smaller size and less weight, with consequent less hazard of excessive carbon pick-up.

17. Less material on which to pay freight because of the lower rate of consumption. This is a particularly important consideration in the case of customers at long distances from an electrode plant.

18. Less storage space is required because of the lower usage.

Some Carbon Advantges

On the other hand, factors favoring the use of the equivalent larger carbon electrode are:

1. Lower cost per lb. The price of carbon electrodes is about half that of graphite, somewhat more than compensating for the difference in consumption rates.

2. Better heat distribution is effected because the larger cross-section covers a greater portion of the hearth. This is of greater importance in submerged arc applications.

3. The larger diameter retards the rate of boring* through the charge, with less danger of burning into the bottom.

4. Thermal conductivity of carbon is only about one-twelfth that of graphite, so that a carbon electrode of even twice the cross-sectional area of a graphite electrode nevertheless conducts only one-sixth the amount of heat out of the furnace. Other factors being equal, this effect tends toward cooler holders and a little better power efficiency. However, in most instances this favorable tendency is more than offset by the greater electrical resistance of the carbon electrode.

5. Mechanical strength of carbon stock runs only 75 per cent or so of that of corresponding graphite, but as transverse breaking strength varies as the cube of the diameter, a carbon electrode of twice the cross-sectional area of a graphite electrode will have approximately twice the resistance to breakage under cantilever forces, modified to some extent by a certain difference in brittleness, or susceptibility to impact shock.

6. Where electrode "dipping" to carburize is practiced, the lower unit cost of the carbon electrode will be in its favor.

Consumption Rate

For carbon and graphite electrodes having a ratio of cross-sectional areas in the neighborhood of 2 to 1, rate of consumption is so nearly the same as to be of no consequence. Thus, for electrodes of equal length the frequency of joint assembly is not a factor.

These then are the important considerations in making a decision whether to apply carbon or graphite electrodes. In general, a good steel of any of the common specifications can be made with either kind, although the factor of safety is possibly slightly greater with graphite.

However, in the case of most of the big, high-powered furnaces, where even the large graphite electrodes are often near their conventional current capacity, the appro-

Installing an electrode on electric arc furnace. Great care should be exercised in making the electrode joint.

priate carbon electrode, even though available, is too massive to be practicable. If the particular circumstances weigh heavily in favor of carbon, a compromise may be made in which the largest feasible diameter is used, with a certain reduction in power and sacrifice in rate of production.

Superior Qualities. The carbon or graphite electrode, in performing its primary function of conducting the electric current to that place in the furnace where the electrical energy is changed to heat energy, must meet the following fundamental requirements:

1. High electrical conductivity, high current-carrying capacity and low power consumption.
2. Satisfactory mechanical strength and freedom from internal structural flaws.
3. Trueness of form and uniformity of dimensions.
4. High resistance to thermal shock and freedom from body and end cracking and spalling.
5. Uniform quality and dependability of performance.
6. Low initial cost.
7. A machined joint easy of assembly and having the best possible electrical and mechanical properties.
8. High resistance to oxidation and a low rate of consumption.
9. Infusibility at any known temperature.
10. Ability to produce and sustain an electric arc which gives the highest possible temperature essential to the manufacture of products in electric furnaces.

Electrode Characteristics

Electrothermic carbon and graphite electrodes for many years have met, in general, the factors of quality as defined by these ten basic requirements. They are good conductors of electric current; they do not melt at any known temperature; and they possess that characteristic which permits of the change of electrical into heat energy at the arc end to produce a temperature of approximately 6870° F.

Furthermore, carbon and graphite electrodes possess a thermal conductivity that is high in comparison with most metallic solids, and this property, in combination with low thermal expansion, gives them good resistance to heat shock.

Present-day electrothermic electrodes, particularly in the large sizes, are subject to four principal criticisms: oxidation, joint failures, cracking and breaking, and end spalling.

Oxidation. At temperatures of 2900-3200° F. attained by most steel furnaces, and in the presence of air, carbon and graphite oxidize readily and this oxidation is responsible for from 60 to 75 per cent of the total electrode consumption. Although such loss of material is serious, the decrease in electrode strength and conductivity, due to diminishing diameter as it approaches the arc end, are of greater importance.

The reduction in diameter also weakens the threaded socket walls, a condition that gives rise to joint failures. It should not be forgotten that the combination of heat and air always will result in electrode oxidation and that any procedure that reduces either will improve this trouble.

Importance of Joining

Joint Failures. At least 90 per cent of all major electrode difficulties spring from the need of joining them together. This is due to a number of reasons, among which the following should be emphasized:

1. The joint is obviously a point of relative mechanical weakness which is greatly aggravated by oxidation of the socket walls.
2. Poor joint assembly due to the presence of dirt and dust in the sockets, damaged threads, careless joining technique, and insufficient tightening torque.
3. Loose joints due to excessive vibration of the furnace gallows arms and poor electrical contact between electrode and charge.
4. Careless use of metal lift plug in transferring electrodes from storage to the furnace roof platform.
5. Tendency for cracks to originate at the ends of electrodes because stresses concentrate at the intersection of the arc and surfaces.

Breakage. Electrode cracking and breakage give infrequent trouble to the electric furnace operator. Such difficulties are due to the following conditions:

1. When the mechanical, thermal, and electrical conditions imposed at any point give rise to stresses which exceed the strength of the electrode at that point.
2. Loose gallows arms which through vibration cause loosening of joint with subsequent breakage to connecting pin or the socket wall.
3. Off-center holders which place excessive strains on the body and joints of the electrode.
4. Poor electrical contact between charge and end of electrode columns, thus causing an end thrust on the electrode which loosens, weakens, and causes a fracture at the joint.
5. Careless use of charging machine or charging methods which result in mechanical impact shock to the electrode column.
6. Presence of a mechanically defective electrode.

End Spalling. Spalling is a condition which applies to the losses from the tips of the columns, which occur as a result of the local stresses set up by the sharp thermal gradients in the vicinity of the arc. It is a condition noted in high-power service and represents a substantial proportion of the consumption due to causes other than oxidation.

The occurrence of spalling is related chiefly to the inherent properties and structure of the electrode material itself, and the chief objection to this condition is the resultant serious carbon contamination of critical and expensive heats of stainless steel. The trouble is most prevalent in operations where the hot electrodes are withdrawn suddenly from the furnace at the end of the heat, or a number of times during the melt-down and refining of the heat.

Improvement in electrode cracking will be noted, therefore, if the operator will follow the principle of retarded cooling and withdraw the electrodes slowly from the furnace either at the end of the heat or when "back charging." Time will vary with size and type of operation and the details will have to be worked out in every case.

Precautions

In view of the limitations of the electrode product as outlined, emphasis should be placed upon certain precautions which must be taken in order to obtain optimum operating results.

Handling Electrodes. Particular care should be used to see that proper equipment and handling technique are applied to the movement and storage of electrodes. Storage racks should be provided and located in a clean, dry place, and every care should be taken to

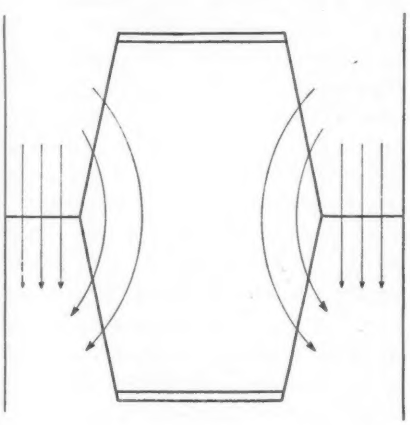
minimize surface abrasions, chipping of end faces and damage to threads in the sockets.

Serious bumps in unloading, the use of unprotected pinch bars in sockets or on end faces, and the careless use of lift plugs are procedures to be frowned upon. Carelessness in handling may lead to serious breakage during actual use in the furnace.

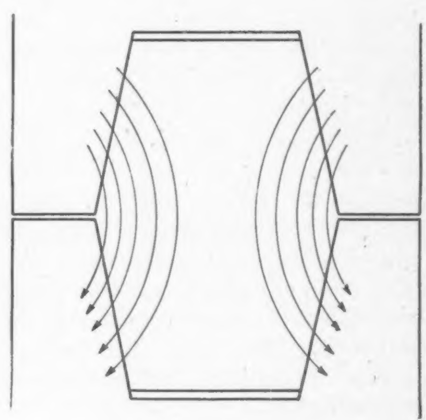
Joint Assembly. Reference has already been made to the limitations of electrode products through joint failures. These can be materially reduced in extent and degree by strict adherence to the following:

1. Thoroughly clean the upper socket of the electrode with compressed air.

2. Pick any heavy particles from the socket by hand. If necessary, wipe the end face with a cloth to remove any residual deposit.



Electrode joints must be clean and tight since approximately two-thirds of the current passes across the interface. In a loose joint, most of the current is carried by the nipple, causing the nipple to become hot and expand, sometimes splitting the socket. Left—Clean, tight joints. Right—Loose or dirty joint.



3. Carefully insert a clean, undamaged nipple in the socket.

4. Center the new electrode over the column, give its lower socket a final blowing out, and then lower the section until its bottom end is within 4 to 6-in. of the top end of the column.

5. Maintaining the crane hook stationary, carefully revolve the electrode by hand while an assistant raises the column by means of the furnace control.

6. Continue to screw the electrode onto the nipple, using the recommended chain wrench when it becomes too difficult to turn by hand, until the gap between the end faces is reduced to about ¾-in.

7. Thoroughly blow out the space between the end faces with compressed air in order to remove any chips or dust.

8. Tighten the joint to a snug fit and then, combining the efforts of two men, apply as great force as possible up to the limiting torque specified for the particular size of electrode involved.

9. Slip the column until the joint section is definitely below holder.

In the assembly of carbon electrodes with carbon nipples, the procedure is the same except that the nipple is dipped, first one end and then the other, in properly thinned joint compound before inserting it in the column. In the assembly of carbon electrodes with graphite nipples, cement is applied only to the end faces of the electrodes.

Mechanical Breakage. Unnecessary mechanical breakage generally is caused by a number of factors among which may be mentioned:

(*a*) *Loose Gallows Arms*—The gallows arms are sometimes so poorly fitted to the uprights that they bind when put into motion by the automatic controls and cause a vertical vibration. This vibration is worst at the electrode end and often shakes the joints loose. The trouble should be immediately repaired by the plant mechanic.

Keyways in the gallows arms wear loose and allow a side motion in the arms. The electrode jumps from side to side when striking the arc end. When the movement is serious, it allows a side slap when tilting the furnace, thus causing joint breakage.

(*b*) *Off-Center Holders*—Every possible care should be taken to make certain that the electrode holders are centered exactly over the openings in the roof, since binding at this point usually will result in breakage. Whenever the roof is changed, this point should be carefully considered and care should be taken to see that the holders are vertical regardless of the position of the holder above the roof.

The easiest way to determine these points is to grip a full-size section of electrode near its upper end and run it up and down the full length of the holder arm travel, constantly examining the clearance between the roof and the electrode, rather than between the roof gland and the electrode. This procedure should be carried out on all three phases.

(*c*) *Poor Contact*—A great deal of mechanical breakage is caused by poor contact between the electrodes and the charge, due to the use of a poor grade of scrap coated with a layer of sand or rust. This coating serves as an insulation so that the electrodes do not make proper contact on reaching the scrap and therefore are not raised by the automatic controls.

Consequently, the weight of the two electrode sections and gallows arms comes down on the scrap, causing an end thrust on the electrode which loosens, weakens and causes a fracture at the joint. Even if the arc finds a point of contact through the coating, the electrode receives a violent electrical surge until the contact is broken.

Considerable care should be used, therefore, to guard against charging too great a percentage of insulated scrap in any one charge. If poor scrap is to be used, it should be placed in the furnace first and covered with good scrap. Under these conditions melting will proceed without difficulty.

(*d*) *Poor Joint Assembly*—The joint is, of course, the weakest part of an electrode and every precaution should be taken to prevent any

unnecessary strains at this point. It should be emphasized that a tightly locked joint is probably one of the most important factors in eliminating mechanical breakage due to pin and threaded cavity failures. Therefore, too much attention and care cannot be paid to the technique of joint assembly.

(*e*) *Loose Joints*—The comments pertaining to poor joint assembly also hold true in the case of loose joints. If a joint is improperly made or has been loosened by vibration, poor electrical contact, or other causes, it is in poor condition to carry the current densities to which it is subjected.

Due to the poor contact in a loosened joint section, internal arcing often occurs and hot spots are noticed almost immediately. If such a condition is allowed to continue, rapid deterioration of the joint section will follow, thus causing failure at the joint with the electrode only partly consumed.

A loose joint means that the pin is called upon to stand all of the mechanical strains, with the result that pin breakage usually follows at considerable stub loss expense.

If a joint is properly made to begin with and is kept tight during all stages of operation, joint failures will be reduced to a minimum and a corresponding electrode saving will be made.

(*f*) *Charging Furnace*—The electrodes should be raised as high as possible before tilting the furnace for charging, so that the danger of striking them is reduced. When the furnace is charged by machine, crane, or hand, every precaution should be taken not to strike the electrodes, since a light blow on the end of an electrode when the furnace is in the tilted position causes a heavy strain on the joint.

Care in Charging

This strain sometimes fractures the pin or the threaded section. Since breakage of this kind means money wasted, it is worth while to use every possible care in the charging operations.

Electrical Conditions. High electrode consumption is sometimes due to the use of poor electrical conditions on the furnace. For example, if too low a voltage is used during the refining period, the arc gap will be too short, thus allowing the slag or the metal to wash against the electrodes. A recent experience of this kind was noted, but after a longer arc gap was used the electrode consumption decreased approximately 17 per cent.

Other poor electrical conditions may be mentioned, such as poor operation of the automatics, unbalanced phase loads, and the use of inferior or damaged instruments on the meter board. These points should be carefully checked by the chief electrician from time to time and every care taken to see that they are constantly under control.

The development of carbon and graphite furnace electrodes during the past 25 years, both in size and quality, has represented substantial progress. In 1920 the largest carbon electrode was 24 in. diameter and 84 in. long, whereas in 1945 the largest graphite electrode was 40 in. diameter and 110 in. long. In 1920 the largest graphite electrode measured 14x60 in.—in 1945 the largest graphite electrode commercially available had grown to 30 in. diameter, 84 in. long.

Electrode Loads Changed

In 1920 carbon electrodes were not required to handle electrical loads in excess of 25 amperes per sq. in.; today this type of electrode is frequently called upon to carry currents as high as 100 amperes per sq. in. In 1920 the recommended current densities for graphite electrodes ranged from 80 to 200 amperes per sq. in., while in 1945 they varied from 100 to 400 amperes per sq. in.

The outstanding handicap of the past has been the lack of a yardstick with which to accurately measure the quality of the electrode for each specific task. Thus the electrode manufacturer has often been obliged to approach his technical problems through trial and error. The past few years, however, have seen a growing spirit on the part of industries using electric furnaces to cooperate with the electrode manufacturer in the solution of common problems.

Through a broad program of fundamental research on raw materials and manufacturing processes, and accurately controlled tests of electrodes under actual furnace conditions, facts now are being established on which the principles underlying the technology of electrode manufacture can be based. With such procedures leading the way, it is confidently believed that developments in the electrode industry during the next decade will show even greater progress than those of the past.

The electric steel industry has enjoyed a distinguished past. It is a vital and permanent part of our modern existence, and will continue to meet the demands of the postwar period. Carbon and graphite electrodes will continue to perform an essential role in the progress of this industry.

F. R. Fleig New Head Of Foundry Suppliers

RECENT REORGANIZATION of the Foundry Supply Manufacturers Association, which has established new headquarters in the Engineers Building, Cleveland 14, was accompanied by election of a group of officers long associated with foundry organization: *president,* F. Ray Fleig, Smith Facing & Supply Co., Cleveland; *vice-president,* E. H. King, Hill & Griffith Co., Cincinnati; and *executor director and treasurer,* A. J. Tuscany, Arthur J. Tuscany Organization, Cleveland.

Currently Treasurer, Northeastern Ohio A.F.A. chapter, Mr. Fleig also has served as a Director and as Chairman of the chapter. He is a graduate of the University of Illinois, Urbana, and has been associated with the Smith firm for 33 years, the last ten as company president.

Long interested in foundry work, Mr. King conducted research in sand problems during his college days, and since has served on local and national A.F.A. committees. He was Chairman, Cincinnati A.F.A. chapter, for the 1943-44 season. Following several years as sales manager for the Hill & Griffith firm, he was appointed vice-president and general manager in 1944.

Mr. Tuscany has been continuously identified with the foundry industry since 1922, in which year he assumed the position of executive secretary, Ohio Foundrymen's Association. He now serves as executive secretary, FEMA.

NEW COMMITTEES
Added to A.F.A. Steel Division

THREE NEW COMMITTEES for the A.F.A. Steel Division were established and division organization and activities were thoroughly discussed as the Executive and Program and Papers committees held a joint meeting at the Statler Hotel, Cleveland, September 5, with Dr. C. H. Lorig, Battelle Memorial Institute, Columbus, Ohio, Division Chairman, presiding.

Recent decisions of the A.F.A. Board of Directors in regard to technical committee organization, planning of technical activities and development of an A.F.A. research program, formed the background against which the joint meeting plotted the course of division undertakings for the forthcoming year.

Advisory Group

Consideration was given establishment of an Advisory Group of outstanding steel foundrymen who might be called upon by the Division Chairman or Executive Committee for special assignments; and membership of the group is to be announced in the near future by Dr. Lorig.

New technical groups decided upon were the division *Research Committee, Committee on Steel Casting Service Failures* and *Committee on Handbook of Steel Melting Practice.*

The research body will, of course, conceive, recommend, plan, supervise and report on worthwhile projects for investigation, making suggestions for such projects to the A.F.A. Executive Committee, and carrying through on the undertakings after their approval.

Committee Objectives

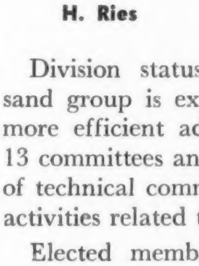
Case histories of typical service failures of steel castings will be accumulated by the second group, and corrective measures suggested; while the Handbook committee will correlate steel melting information already available, with the objective of publishing a handbook for steel foundries similar to the HANDBOOK OF CUPOLA OPERATION, prepared by the Gray Iron Division.

Also discussed in detail at the meeting was the Steel Division program for the 1947 Annual Convention. Papers already in preparation were reported, and suggestions were made as to additional technical discussions. E. C. Troy, Dodge Steel Corp., Philadelphia, was named Chairman, Subcommittee on Steel Round Table, and charged with the responsibility of planning the convention round table meeting.

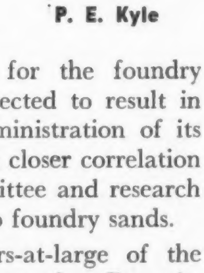
Sand Group Becomes Seventh A.F.A. Division

TRANSFORMATION of the A.F.A. Foundry Sand Research Project, organized in 1921, into the seventh technical division of the Association, the A.F.A. Sand Division, was accomplished at a meeting of the Executive Committee of the group at the Statler Hotel, Buffalo, N. Y., September 11. Formation of the new division is part of the over-all reorganization program approved by the A.F.A. Board of Directors at its Annual Meeting in July.

Sand Division Chairman is Dr. H. Ries, formerly head of the geology department, Cornell University, Ithaca, N. Y., and Vice-Chairman is P. E. Kyle, professor of metallurgy at Cornell University.



H. Ries



P. E. Kyle

Division status for the foundry sand group is expected to result in more efficient administration of its 13 committees and closer correlation of technical committee and research activities related to foundry sands.

Elected members-at-large of the Sand Division's Executive Committee at the meeting were Col. A. I. Krynitsky, National Bureau of Standards, and H. M. Kraner, Bethlehem Steel Co., Bethlehem, Pa. Consideration was also given selection of the Advisory Group for the division, and Dr. Ries is to announce membership of that body in the near future.

Activities and objectives of committees were discussed thoroughly. Decision was reached to continue the Grading and Fineness, Flowability, Mold Surface, Core Test, Green Sand Properties and Deformation committees; the subcommittees on Core Gas and Moisture Absorption, Core Washes and Pastes, and Core Strengths; the Committee on Physical Properties of Foundry Sands at Elevated Temperatures, and its three subcommittees.

Technical phases of the sand research project at Cornell University will be under the direction of the Subcommittee on Physical Properties of Steel Foundry Sands at Elevated Temperatures.

The technical program for the 1947 convention and the status of several papers to be included were discussed at length; and plans were laid to follow up, in order that the program may be completely organized within a short time.

Museum Exhibit

(Continued from Page 39)

that about half of those who go through the Museum come from outside of Illinois, with representation from every state in the Union and from Canada. The operating foundry exhibit, therefore, serves the foundry industry on a nation-wide scale by carrying its story to a cross section of the country's citizens.

The castings exhibit was dedicated on November 9, 1939, during the Second Chicago Regional Foundry Conference, sponsored jointly by the Chicago chapter and the Museum of Science and Industry. Noting the start of work on the institution in 1938, the chapter had interested itself in establishment of a foundry exhibit; had secured space allocation in the building and the necessary equipment from interested foundry firms in the area; and had raised an operating fund.

Later, the chapter, realizing the effect of longer periods of operation on public interest, was instrumental in making available commercial patterns and funds so that molding-pouring demonstrations could be presented five days a week. At the end of the war, however, it was necessary to reduce the schedule.

SILICON PICK-UP IN MELTING MALLEABLE IRON

A correlation of the theory of silicon pick-up with data obtained in normal malleable iron melting practice. High temperature, high carbon contents, time at high temperatures, and high silica content of refractories and slag are factors promoting increased silica content.

J. E. Rehder
Grinnell Co. of Canada Ltd.
Toronto, Canada

It is well known that silicon can be introduced into the iron in steelmaking operations on acid bottoms and in crucible melting of tool steel, presumably by reaction of the carbon in the iron with the acid lining or slags. Apparently, the effect is dependent upon temperature, the rate of silicon pick-up increasing rapidly as the temperature rises.

In melting or duplexing malleable iron in the air furnace or electric furnace, this silicon pick-up can be of importance, since, for a given practice, an increase in silicon over a certain amount will produce mottled iron. A knowledge of the precise effect of temperature is an important factor in adhering to a specified analysis for silicon (and carbon). It is proposed here to investigate the theory underlying the phenomenon of silicon pick-up, and to correlate the theory with results observed in practice.

Theory

The basic chemical reaction responsible for the introduction of silicon into molten iron containing carbon probably is

(1) $$2C+SiO_2=Si+2CO$$

To take into consideration conditions in a bath of liquid iron, equation (1) may be written

(2) $$2C(\text{in Fe})+SiO_2(s)=Si(\text{in Fe})+2CO(g)$$

The possibility of this reaction occurring in an appreciable extent may be determined by considering the free energy changes involved. From fundamental data given by Chipman[1] the free energy change involved in equation (2) is found to be

(3) $$\Delta F=102{,}180-58.7T$$

From equation (3), upon dividing by -4.575 T,

(4) $$\log K=\frac{-22{,}334}{T}+12.83,$$

and applying the "Mass Law" to equation (2)

(5) $$K=\frac{(CO)^2.Si(\text{in Fe})}{(C\text{ in Fe})^2.SiO_2\ (s)}$$

where

- CO=partial pressure of CO.
- Si(inFe)=activity of silicon in iron.
- C(inFe)=activity of carbon in iron.
- $SiO_2(s)$=activity of $SiO_2=1.0$ when free solid SiO_2 is present.

Range of temperatures over which the reaction is of interest here is from about 1450° C. (2642° F.) to 1650° C. (3002° F.). Table 1 shows how the equilibrium constant varies over this temperature range, as found from equation (4).

The relationship of K to temperture is plotted in Fig. 1. It is apparent (Fig. 1) that at temperatures above about 1540° C. (2804° F.) the equilibrium constant (and therefore the equilibrium silicon content of the iron) increases rapidly.

Table 1
Effect of Temperature on K

°C.	*°F.*	*log K*	*K*
1477	2690	0.068	1.170
1527	2780	0.423	2.649
1577	2870	0.758	5.728
1627	2960	1.076	11.91
1677	3050	1.377	23.82

Equation (5) may be rewritten

(6) $$Si(\text{inFe})=K.\frac{(C\text{inFe})^2.SiO_2(s)}{(CO)^2}$$

Equation (6) indicates that at constant temperature the amount of possible silicon pick-up increases as the activity of silica and the square of the activity of carbon in the iron, and decreases as the square of the partial pressure of carbon monoxide. Since at metal-furnace bottom and metal-slag interfaces the partial pressure of carbon monoxide is approximately one atmosphere, equation (6) may be further modified:

(7) $$Si(\text{inFe})=K.(C\text{inFe})^2.SiO_2(s)$$

From further data by Chipman[2], the activity of carbon in iron in the range 2.30 to 2.80 per cent can be represented to a first approximation, as shown in Fig. 2, and the activity of silicon in iron as shown in Fig. 3.

Carbon and Silicon

For a given carbon and silicon content in the iron, the activities of carbon and silicon for use in equation (7) can be taken from Figs. 2 and 3. For general purposes, not involving calculation, equation (7) may then be written

(8) $$\%Si(\text{in Fe})=K.(\%C)^2.SiO_2(s)$$

Reduction from Silica Bottom. In discussing the application of equation (8) to malleable melting practice, it is assumed for the moment that the furnace bottom is of silica sand, and that the liquid metal has a slag covering. These conditions are usual in air furnace practice.

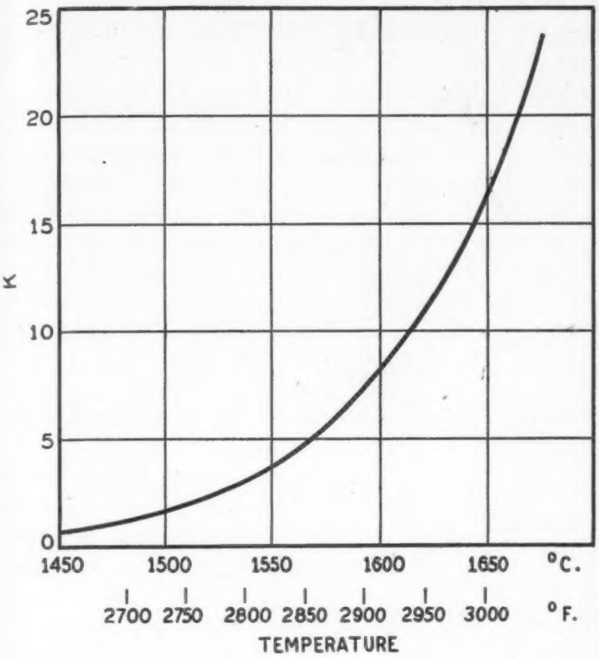


Fig. 1—Effect of temperature upon equilibrium constant.

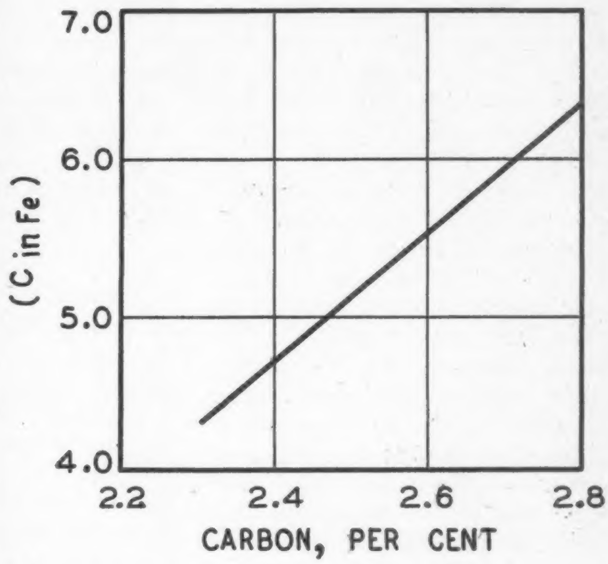


Fig. 2—Activity of carbon in iron (equation 7).

Fig. 3—Activity of silicon in iron (equation 7).

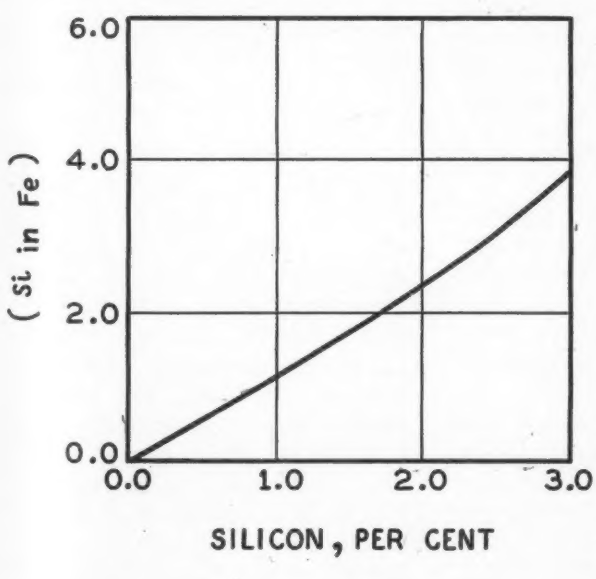
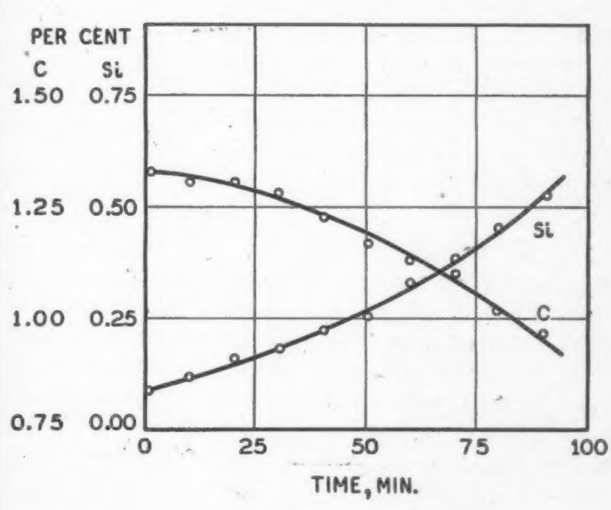


Fig. 4—Increase of silicon in high carbon steel melt (equation 1).



Since a silica bottom is present, the activity of silica is 1.0, and to a first approximation equation (8) under these conditions becomes

$$(9) \quad \%Si(\text{in iron}) = K.(\%C)^2$$

Then, in melting malleable iron on a silica bottom, the equilibrium silicon content of the iron will increase with the temperature, as shown in Fig. 1, and with the square of the carbon content of the iron.

Reduction from Slag. Slags encountered in an air furnace practice melting malleable iron are composed essentially of iron, alumina and silica, with a small amount of manganese, i.e., 20 to 25 per cent FeO, 20 to 25 per cent Al_2O_3, about 5 per cent MnO, and 45 to 50 per cent SiO_2.

In applying equation (8) to determine possible reduction of silica from the slag, the activity of SiO_2 will therefore be less than 1.0, the exact value depending upon the amount and type of compound formation within the slag and the amount of resulting "free" SiO_2.

The compound formation and amount of "free" SiO_2 are also functions of the temperature of the slag, so that the value of activity of SiO_2 to be used in equation (8) in connection with the slag is an indeterminable factor at present, but between 1.0 and zero. However, for a given slag and temperature the activity should be definite and reproducible. The conclusion is that the amount of silicon reduction from an air furnace slag is difficult to determine at present, but almost certainly is considerably less than that from a silica bottom at the same temperature.

Oxidizing Potential

Another factor entering into the consideration of the slag is that the oxidizing potential of the slag can change with the character of the flame (usually pulverized coal in an air furnace) providing heat, so that the slag may be actively oxidizing toward the surface of the iron bath, or may be practically neutral.

Therefore, with a bath of iron at, say, 1590° C. (2894° F.) and with a hot, oxidizing flame, the net amount of silicon introduced into the metal will be a balance between reduction from the bottom and oxidation at the surface of the bath. With the same bath temperature, then, the character of the flame will have an effect upon the net silicon pick-up.

Reduction from Brick Bottom. In large air furnaces and in air furnaces used for duplexing, brick bottoms usually are employed. In these cases the considerations for reduction of silicon are, in general, the same as for reduction from slags. However, there is a difference in that the composition of the bricks is relatively constant and, of course, the character of flame in the furnace has no direct effect upon their composition.

Silicon Pick-up

The activity of silica to be used in equation (8) will therefore be less than 1.0, but should vary in a regular way with temperature once determined. Therefore, silicon pick-up from a brick bottom will be possible, although probably amounting to less for a given temperature and iron composition than that from a silica bottom.

Electric Furnaces. In electric furnace melting or duplexing of malleable iron, the same discussion will apply as for air furnaces. However, effective differences are that the atmosphere in electric furnaces usually is reducing, so that slags are likely to be less oxidizing; and that local conditions around the electrodes (high temperatures, excess carbon) are conducive to reduction of silicon from the slag. In the latter case the total percentage of silicon entering the metal may be small due to the relatively small electrode areas.

A series of experiments reported by Bardenheuer[4] provide some corroboration of the theory developed in the foregoing. In the first of these a high-carbon steel was melted in a high-frequency induction furnace at 1650° C. (3002° F.). The melt-down slag was removed and replaced by a straight silica slag low in ferrous oxide. Figure 4 shows a graph of carbon and silicon contents versus time at a temperature of 1650° C. (3002° F.).

Conditions here (Fig. 4) were quite favorable to silicon increase, as the slag was high in SiO_2, the crucible presumably of silica, and the temperature high. It will be noticed that the increase in silicon and the decrease in carbon after 90 min. are in stoichiometric proportions for equation (1).

In another series of tests Bardenheuer[4] determined the effect of temperature upon the rate of increase of silicon in a melt of iron, and the results are shown in Fig. 5. Comparison of Fig. 5 with Fig. 1 shows that the curves are similar.

Again, Bardenheuer[4] describes an experiment to determine how much silicon can be picked up by an iron melt containing carbon. A charge containing 2.2 per cent of carbon and 0.0 per cent of silicon was melted in a high-frequency induction furnace with an acid lining, and the melt-down slag replaced with a straight acid slag. The melt was held for 38 hr. in the furnace, and then tapped.

During the 38-hr. period, carbon was added to the melt to replenish that lost. The amount of carbon added and the temperature of holding are not given. The metal as tapped was found to contain 3.72 per cent of silicon and 0.16 per cent of carbon. Apparently, large quantities of silicon can be introduced into iron melts by action of carbon with acid furnace linings and slags.

In the relatively long time provided at temperature in this test, equilibrium was approached, as calculation of silicon in the iron for 0.16 per cent of carbon from equation (7) and Figs. 2 and 3, assuming approximately 1600° C. (2912° F.), gives good agreement with that found by analysis.

Taking Samples

Sampling of regular air furnace heats by the author has provided data on silicon pick-up in normal malleable melting practice. Samples were taken every half-hour from melt-down to tap-out, from an air furnace melting a cold charge on a silica bottom. The bath was rabbled before taking each sample in order to ensure an average sample. Tap-out time in each case was 3:30 pm, pouring of the heat taking a little more than an hour. Spout temperatures were about 1570° C. (2858° F.).

In the case shown in Fig. 6, the flame was made less oxidizing at about 2:30 pm to increase the carbon content of the metal as it was below specification.

In Fig. 7, the loss in carbon and

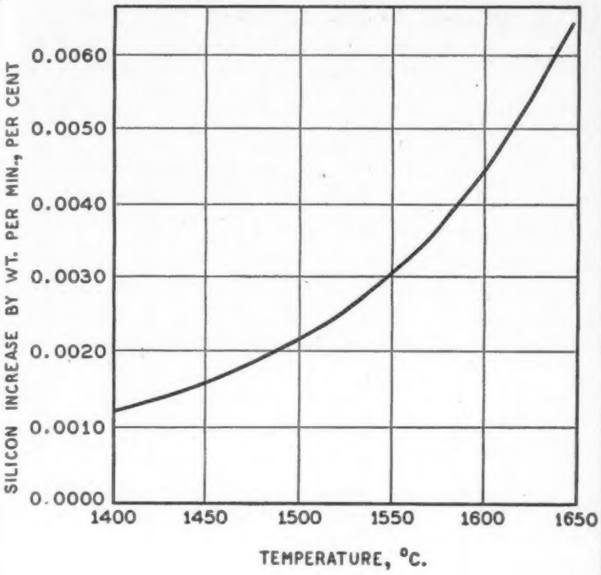


Fig. 5—Effect of temperature upon rate of silicon pick-up (see Fig. 1).

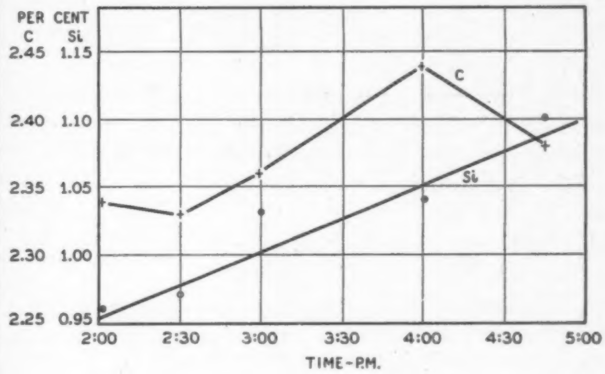
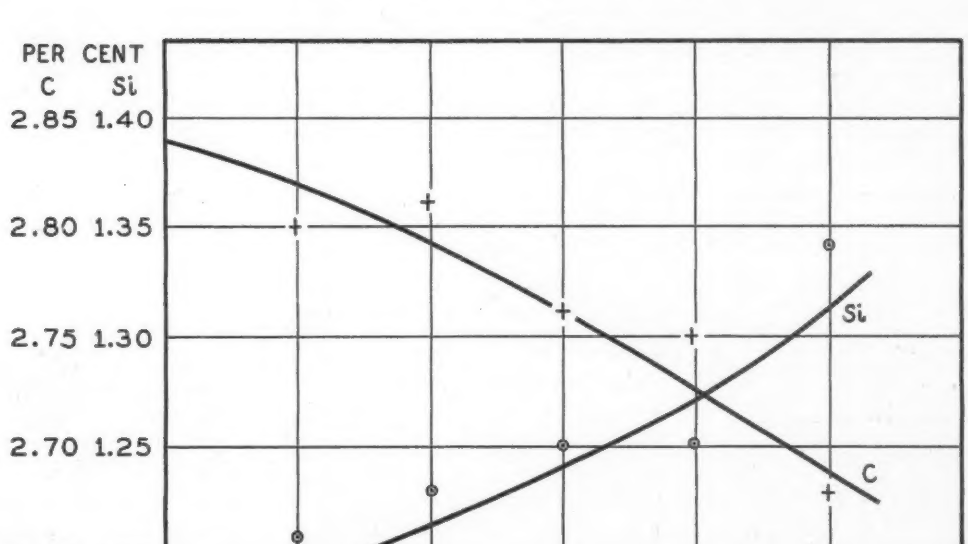


Fig. 6—Low carbon. Changes in carbon and silicon contents during melting period in air furnace.

Fig. 7—High carbon. Changes in carbon and silicon contents during melting period in air furnace.



gain in silicon shown from 1:30 pm to 4:00 pm are in approximately stoichiometric proportion following equation (1).

In the operation of a duplexing air furnace with a brick bottom, silicon pick-up can be pronounced. For an iron with about 2.70 per cent of carbon, air furnace spout temperature over about 1560° C. (2840° F.) marks the temperature above which silicon pick-up in the air furnace becomes rapid. In the author's experience, each 5° C. (10° F.) rise in temperature over 1560° C. (2840° F.) adds four or five points of silicon to the iron up to temperatures of about 1566° C. (2850° F.).

This figure, of course, applies only to a given furnace, rate of "throughput" of iron, and operating conditions. For normal air furnace spout temperature of about 1550° C. (2822° F.) and 2.70 per cent of carbon in the iron, silicon pick-up from the bottom about balances normal air furnace oxidation losses so that the silicon loss from cupola charge to air-furnace spout is about that encountered in the cupola alone.

Conclusions

From the discussion and experimental results presented, it is evident that the theory developed is lent support by the evidence, and conversely that the theory can lead to a clearer understanding of composition changes in the air furnace in melting malleable iron. It can be seen from theoretical grounds that under suitable conditions it is quite possible to tap iron out of an air furnace with a silicon content greater than that of the charge, an experience that is occasionally encountered in practice.

Therefore, the conclusion that an increase in silicon content in iron melts containing carbon (e.g., malleable iron) by reduction from refractories or slag is not only possible but, under certain conditions, can be a major effect, seems justified.

The conditions promoting silicon pick-up from refractories are:

1. High temperatures (1550° C., 2822° F., or over, for significant rates in malleable iron melting).
2. Higher carbon content of the iron, the reduction of silica depending upon approximately the square of the carbon content.
3. Increased time at high temperature.
4. High silica content of refractories and slag.

It should be noted that the effect of factors 1 to 4, inclusive, can be partially or competely nullified by a highly oxidizing slag maintained so by an oxidizing flame or furnace atmosphere.

Acknowledgment

The author wishes to express his appreciation to the management of the Grinnell Co. of Canada Ltd. for assistance and permission to publish the paper.

References

1. John Chipman, *Transactions*, ASM, vol. 30, pp. 853-854 (1942).
2. John Chipman, loc. cit., p. 826.
3. John Chipman, loc. cit., p. 844.
4. P. Bardenheuer, *Die Giesserei*, vol. 30, pp. 161-166 (1943).

Routine Method for Making Cupola Taphole

High degree of trouble-free routine can be established in the making of cupola tapholes*, where special taphole refractory blocks are not available, according to James Timbrell, outlining a simple method in a recent issue of *Foundry Trade Journal.*

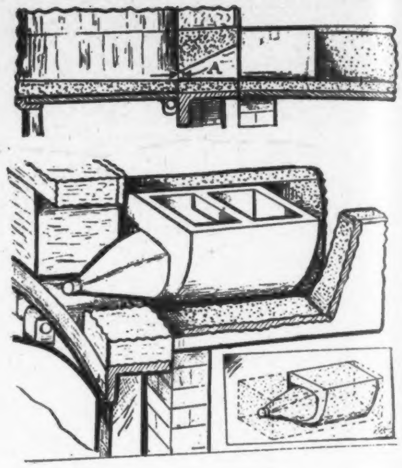
Article describes use of a cast iron former (see cut), shaped to fit gutter bottom and with one end tapered down to contour of taphole desired. Length of tapered section is equal to thickness of the cupola wall in the taphole area, and bottom line of taper is such that the base of the taphole produced is flush with cupola bed and gutter bottom.

Making Taphole

To make taphole, the iron former is inserted in the gutter, with tapered section extending through cupola wall, and refractory material is rammed up from inside of cupola. Metal former is then withdrawn.

Pattern for the former may be shaped from a block of dried core, which is stoned or filed down to taphole and gutter bottom shape. Desirable taphole size is given as ⅝ in. for melt of three tons per hour with approximately 10-cwt. taps, and up to 1⅛ in. for heavy taps on cupolas up to ten tons per hour.

*For a comprehensive discussion of cupola tapholes, and other aspects of operations, see Handbook of Cupola Operations, published by A.F.A.



Top, section through gutter, metal former and cupola wall, showing how former is placed for ramming up refractory material and making taphole. Note: bottom of tapered section lines up with gutter bottom and cupola bed. Parallel section "A" must be extended when heavy metal pressure exists within cupola. Below, close-up view of cast iron former in place, and (inset) method of cutting pattern for former from block of dried core.

Botting mixture recommended for small and frequent taps is: 50 per cent fireclay, 40 per cent floor sand, and 10 per cent coal dust. Components are sieved dry, then dampened enough to make a homogeneous and plastic mixture. Bots made from this mixture are said to dry out quickly in taphole and disintegrate easily when tapping is performed with a pointed rod. More clay should be added in the case of heavy taps, in order to render bots more refractory and less friable.

Can You Help?

In view of a number of recent references, A.F.A. is interested in obtaining for its technical library a copy of the book, *History of the Manufacture of Iron in All Ages,* by James M. Swank, published by the author in 1884.

If you have available a copy of this volume, please write to: The Secretary, American Foundrymen's Association, 222 W. Adams St., Chicago 6.

KNOCK-OFF RISERS

NON-FERROUS CASTINGS

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NECKED-DOWN RISERS for castings is not a novel idea, for it was patented many years ago by Washburn. From its widespread use at the time of Washburn, the necked-down riser gradually lost popularity; then suffered neglect to the point of near oblivion.

However, the cry of the military of World War II for faster manufacture of war materials gave impetus to the making of innovations and the adoption of all manner of short-cut methods. And since Washburn's idea had something real to offer both in the way of economy and speed in the manufacture of castings, it was at once put back into use in nearly all of the nation's steel and iron foundries.

Its entrance into the non-ferrous field, however, is recent. To date, as far as the authors know, no non-ferrous foundry has applied the idea of necked-down risers to castings And this despite the fact that, due to the absence of suitable flame burning methods, there has been a long-felt need for such a riser.

In one or two respects the method of application of necked-down risers to non-ferrous castings has changed beyond recognition. Despite this, the principle involved in its use remains the same.

In a ferrous foundry, a necked-down effect is produced by the use of a thin, water-like core resembling a large washer which is placed between the casting and the riser. The core separates the riser from the casting completely except for a small (½ to 2½-in. diameter) central neck through which the riser metal feeds the casting as it solidifies.

Thin Core

It is important that the core be sufficiently thin to allow the heat from the riser metal and the casting metal to penetrate to such an extent that its effect of chilling the metal is negligible. That is, once the wafer core is heated to the temperature of the metal lying on either side of it, its presence therein appears to exert no interfering influence upon feeding.

Certain definite mass relationships are operative in connection with their employment. From data accumulated on cast iron Washburn risers, the following solid geometry relations are indicated:

a. Diameter of risers should equal or slightly exceed the thickness of the section they feed.

b. Height of risers should at least equal their diameter or thickest cross section and not exceed it by more than 50 per cent.

c. Washburn cores are uneconomical and, what is more important, functionally unreliable for lack of sufficient heat input when the size of the riser is appreciably under 3-in. diameter.

With regard to the application of the principle to non-ferrous risers, the following types of riser neck reducers are employed:

1. Perforated steel sheet screens, tinned or untinned, 0.0125-in. thick by one hundred 3/64-in. diameter holes per sq. in.

2. Refractory disk cores, ⅛-in. to 5/16-in. thick.
   a. Solid graphitic carbon.
   b. Silica core sand.
   c. Gypsum metal casting plaster.

Of the foregoing, only two types have withstood the acid test of practical usage, namely, perforated metal screens and graphitic carbon disks (Fig. 1). This is as it should be when examined in the light of the heat properties shown in Table 1. The appraisement as to advantages, disadvantages and limitations of each is given in the following:

Metal Screens

Advantages

1. Low initial cost (37c per 20x28-in. sheet).
2. Economical storage.
3. Easy handling.
4. Low over-all chilling effect.

Without noticeable impairment of feeding efficiency or sacrifice of metal quality, carbon disks and perforated sheet metal screens are used to give risers which, in the majority of instances, fall off the castings in shake-out or are flogged off with one blow of a hand sledge. Practical methods of making and using gypsum riser sleeves to increase yields in non-ferrous castings have been developed.

Presented at a Brass and Bronze Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 9, 1946, the opinions expressed in the paper are those of the authors, Master Molder and Foundry Metallurgist, respectively, and do not necessarily reflect the views of the Navy Department.

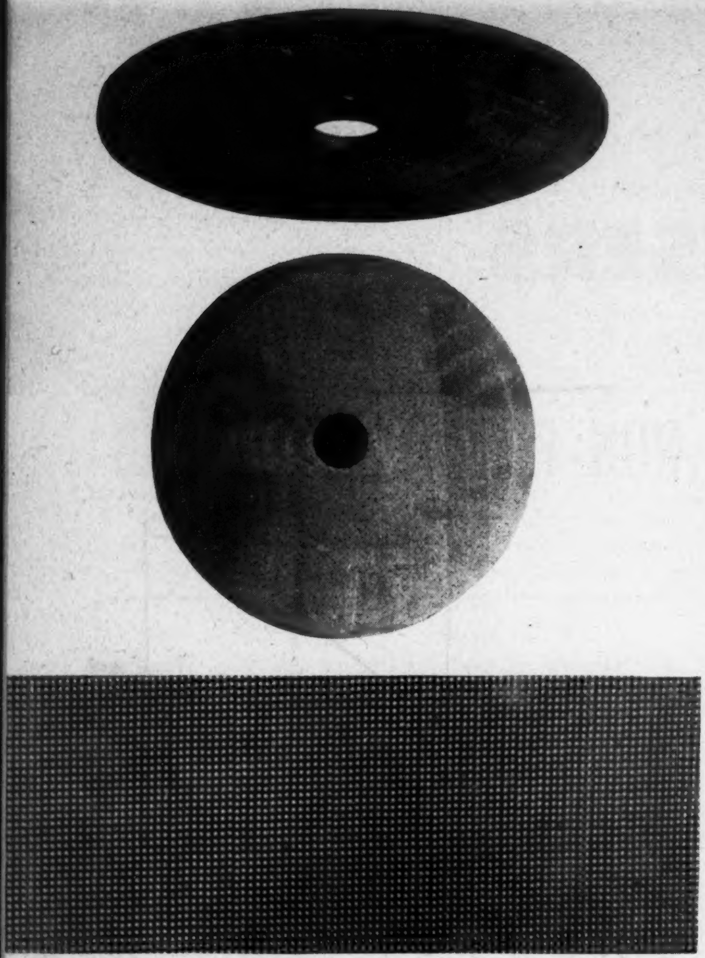


Fig. 1—Perforated metal screen and graphitic carbon disk used to make knock-off risers.

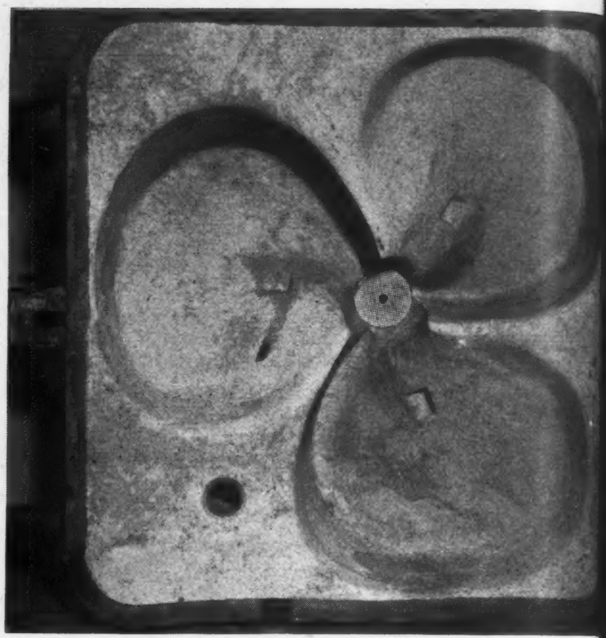


Fig. 2—Mold for 24-in. manganese bronze propeller. Inside surface, cope side, showing location of screen.

Fig. 3—Cope side of mold shown in Fig. 2, outside surface, showing screen and gypsum riser sleeve.

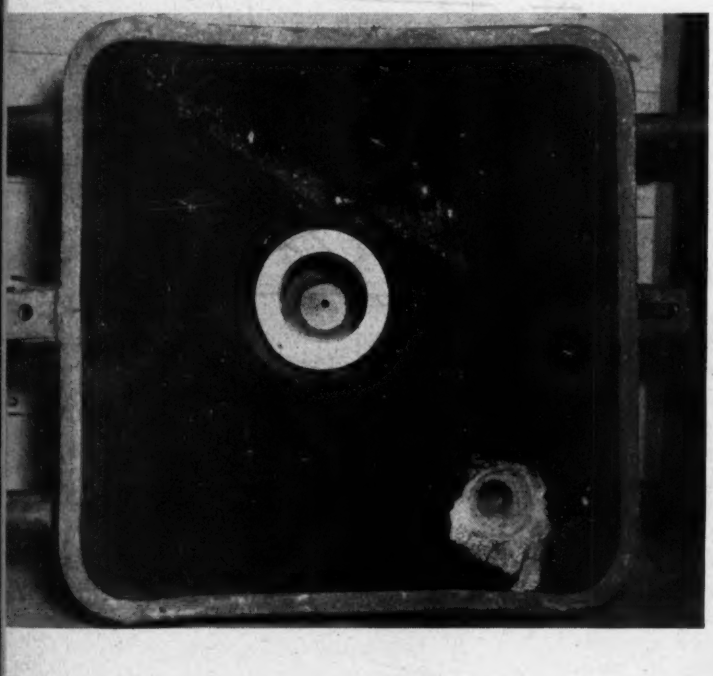
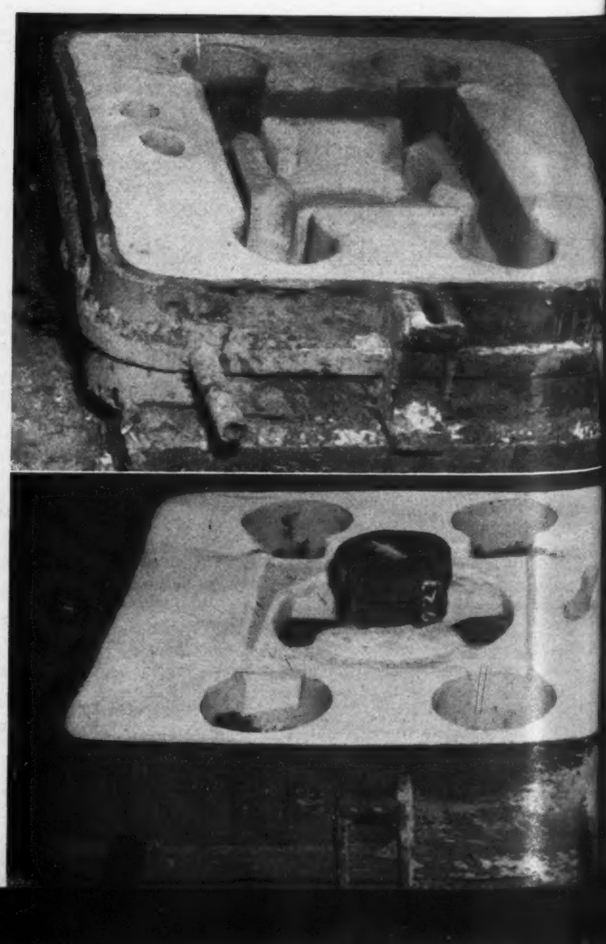


Fig. 4—Mold for manganese bronze deck socket. Note screen in drag in front of two side risers.



Disadvantages

1. Cannot be used on bronzes.
2. Limited in application to brasses and low-tin high-strength bronzes.
3. Cannot be used on large necks, i.e., in excess of 20 sq. in.

Graphite Disks

Advantages

1. Equally operative on bronzes, brasses, and monels.
2. Leaves smooth, flat surface.

Disadvantages

1. Cost slightly more than metal screens.
2. Not recommended for risers under 3½ in. in diameter. Best suited for use with large risers for economical reasons.

Sand Cores

Advantages

1. Best suited for use with steel risers.

Disadvantages

1. Cost more than graphite or metal screens.
2. Conducive to gas entrapment.
3. Warp out of shape, producing bulgy or concave surfaces.
4. Thicker pieces are required for handling than with graphite.

Gypsum

Advantages

1. Has no advantages.

Disadvantages

1. Costs more than any of the other three types.
2. Warps, producing bulgy surfaces.
3. Thicker pieces are required for handling than for any of the other three types.

A brief description of the use of perforated metal screens and carbon disks, as practiced by this foundry, is as follows:

a. Screens of the proper size and form are snipped from 20x28-in. rectangular stock. They are then inserted in their proper place atop the riser neck in the mold and secured to the sand with nails. Figures 2 to 5 are illustrative of their use in molds. The castings made in these molds, including others, are pictured in Figs. 4 to 13, inclusive.

Right—reading top to bottom:

Fig. 5—Cope and drag views of mold (Figs. 2 and 3).

Fig. 6—Propeller casting made in mold shown in Fig. 5. Knock-off riser fell off casting on shake-out.

Fig. 7—Same as Fig. 6. Note amount of flat-bottomed shrinkage in gypsum sleeve.

Fig. 8—Deck socket casting made in mold of Fig. 4 with the two knock-off risers.

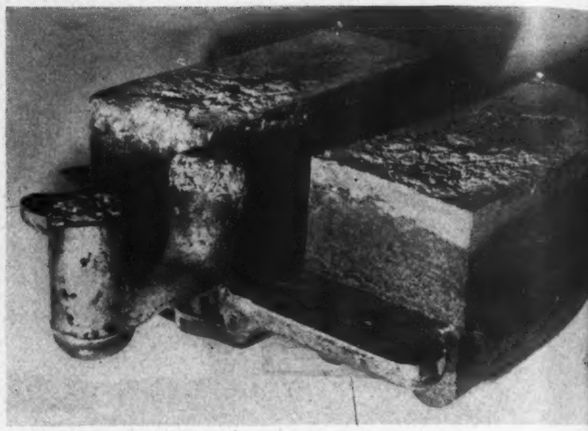


Fig. 9—Keel type manganese bronze tensile test bars. Note double screen underneath riser.

Fig. 10—Manganese bronze deck socket casting showing two kinds of knock-off risers; screen and graphitic carbon (enclosed in gypsum sleeve).

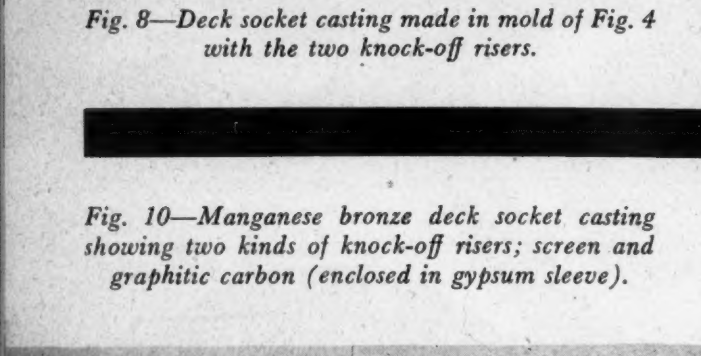
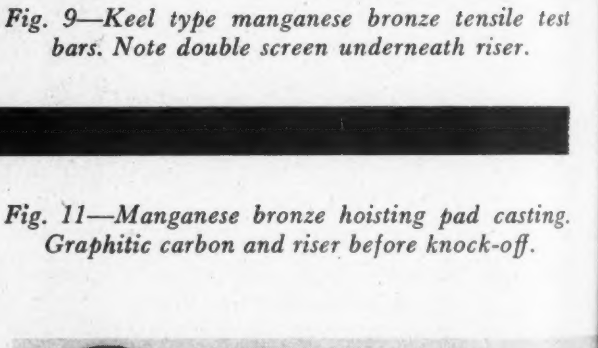


Fig. 11—Manganese bronze hoisting pad casting. Graphitic carbon and riser before knock-off.



Double sheets of screening are sometimes used with the larger risers.

b. Carbon disks are made by first boring a graphite electrode and then sawing off thin slices. The size of disk selected for any given riser is always 2 in. larger than the size of the riser, thus leaving a 1-in. circumferential shoulder for a print, upon the top surface of which is placed a gypsum sleeve.

As to the size of the central hole in the carbon, the test castings shown in Figs. 14 and 15 show that the proper hole size for any casting is equal to 20-25 per cent of the riser diameter. To cause the plane of breakage to locate slightly above the flat surface of the casting, the edge about the hole on either side of the carbon is broken with a file to give it a double-bevel face.

Occasionally, several small ⅛-in. diameter holes are drilled midway between the center and outside of the carbon to aid in the expulsion of mold gases from the mold cavity. Disks are cut ⅛-in. thick for all sizes up to 6-in. diameter, 3/16-in. thick for diameter sizes of from 6 to 10-in., ¼-in. thick for those of greater than 10-in. diameter. Castings generally are gated at the bottom-most point; pouring of metal is continued into the mold until metal comes through neck of carbon; pouring is completed by top pouring of riser.

At present, the use of both of the foregoing neck reducers is restricted to flat surfaces and generally to production set-ups involving 25 or more castings. An exception is made in the case of large castings requiring large risers where an order for one is handled as carefully as orders for large numbers.

Table 2 is offered as a guide for the use of neck reducers for the different kinds of metals and sizes of risers.

Savings effected in cleaning castings by the use of screens and carbon disks are shown in Table 3. Ease and economy are effected in the actual removal of risers by flogging. This economy rests in savings of time, of grinding and cut-off wheels, band saws, chipping chisels, melting electrodes and the attendant metal loss (sawings, chips, spatter), and the labor of sweeping up the same.

Keel block type test bars, with and without metal screens in the riser

Fig. 12—Gun metal bronze casting. 1⅜-in. diameter neck slightly discernable. Made with graphitic carbon.

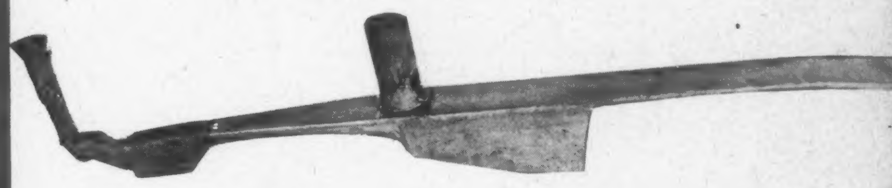


Fig. 13—Manganese bronze skeg shoe casting. Center riser is carbon knock-off type, while end riser is screen type knock-off riser.

Fig. 14—Gun metal billet castings made with carbon knock-off type riser. Sectioned to show solidity of metal; (left)—2-in. diameter billet, ½-in. diameter hole in carbon; (center)—4-in. diameter billet, 1-in. diameter hole in carbon; (right)—6-in. diameter billet, 1⅜-in. diameter hole in carbon.

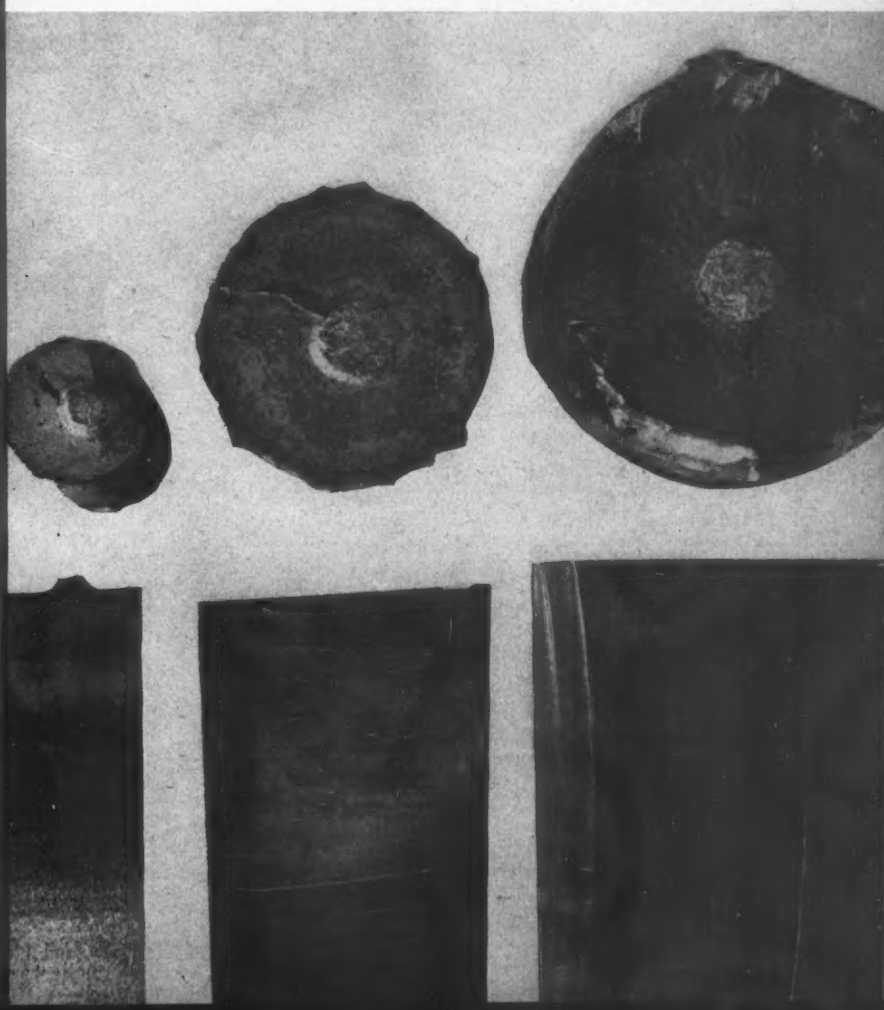


Fig. 15—(above) Same castings shown in Fig. 12, sectioned. Note humping of one casting caused by upward bulging of gypsum core; (left)—carbon, 6½-in. diameter by 1⅜-in. diameter hole; (middle)—gypsum, 6-in. square by 1⅜-in. diameter hole.

Fig. 16—The working tools for making gypsum riser sleeves.

Table 1

Thermal Properties of Materials Used in Knock-Off Risers

Material	*Thickness, in.*	*Diameter, in.*	*Weight, grams*	*Specific Heat at 1000° C. —Cal./G./° C.*	*Total of Calories Absorbed in Heating from 20 to 1000° C.*
Steel	0.0150	4	13.5	0.16[1]	2,140
Graphite	0.1250	4	58.6	0.29[2]	16,650
Core Sand	0.1875	4	79.1	0.26[2]	20,180
Gypsum	0.3125	4	35.9	0.26[3]	9,150

[1]*Handbook of Chemistry and Physics*, p. 1672.
[2]*Textbook of Metallurgical Calculations*, Butts, p. 377.
[3]*Handbook of Chemistry and Physics*, p. 1675.

Table 2

Recommended Materials for Use on Knock-Off Risers

Riser Size, in.	*Bronzes*[1]	*Brasses*[2]	*Monels*[3]
2½	—	Screen	Carbon
3	Carbon	Screen	Carbon
3½	Carbon	Screen	Carbon
4	Carbon	Screen	Carbon
5	Carbon	Screen or Carbon	Carbon
6	Carbon	Carbon	Carbon
8	Carbon	Carbon	Carbon
10	Carbon	Carbon	Carbon
12	Carbon	Carbon	Carbon

[1]N.D. Specifications 46B5, 46M6, 46B8, 46B9, 46M20, 46B21, 46B22, 46B23, 46B24.
[2]N.D. Specifications 46B3, 46M4, 46B10, 46B11, 46B18, 46B29.
[3]N.D. Specifications 46M1, 46N7, 46C8.

Table 3

Comparative Cleaning Costs

	3-in. Diameter Riser	*9-in. Diameter Riser*
Conventional Risers		
Sawing or Chipping	0.180	1.770
Light (Trim) Chipping	0.016	0.033
Dress Grinding	0.033	0.105
Total	0.229	1.908
Flogging Costs		
Screen	0.008	0.060
Carbon Disk	0.080	0.130
Labor to Knock-Off	0.020	0.030
Dress Grinding and Light Chipping	0.025	0.050
Total	0.133	0.270

Table 4

Comparative Physical Properties of Conventional and Knock-Off Riser Metal

	Screen Riser		*Conventional Riser*	
Tensile Strength, psi.	75,500	74,250	73,750	74,500
Elongation, per cent in 2 in.	30.0	30.5	31.5	31.0

neck, were poured from the same heat of manganese bronze and tested as shown in Table 4. No significant difference in physical properties was obtained.

Inasmuch as both of the aforementioned knock-off risers generally are designed for use with gypsum sleeves, it is deemed advisable at this point to include herein a brief description of the technique set up for making and using gypsum sleeves.

The idea of gypsum sleeves for insulating risers is credited to the Naval Research Laboratory. Either regular metal-casting plaster or, preferably, gypsum type R2 are suitable for use in the basic mixture which is prepared as follows:

Gypsum	1 pt.
Cement (by vol.)	2 oz.
Water	1 pt.

This mixture is poured into sheet steel (19 gauge) cylinder molds split longitudinally and buckled together

with two clip fasteners, as shown in Fig. 16. The cylinder rests on towel paper. A tapered aluminum core is centered with respect to the cylinder mold.

Any desired combination of cylinder and core diameter sizes can be selected to make sleeves of any practical wall thickness. "Yard" practice has adopted the 1-in. wall as standard for all gypsum riser sleeves. No anti-sticking sprays are used. Five minutes after pouring, the aluminum core is withdrawn, the metal mold unbuckled, and the gypsum sleeve is air dried for 2 hr., then furnace dried for 10 hr. at 500° F.

After drying, the sleeves are either used immediately or stored in a storage rack. If stored for over 1 day, they are again dried at 400° F. for 15 min. prior to use. When used in non-standard lengths, they are sawed with a hacksaw blade to the required length by the molder.

The graph in Fig. 17 gives the thermal and physical properties of gypsum when used as gypsum sleeve material. The use of gypsum sleeves about the riser, and gypsum powder on top of the riser, results in an increase in riser yield of approximately 30 per cent.

No appreciable contamination of the sand system is encountered from the use of gypsum sleeves. They are hand-picked off the shake-out screen and discarded either whole or in large fragments by the shake-out crew.

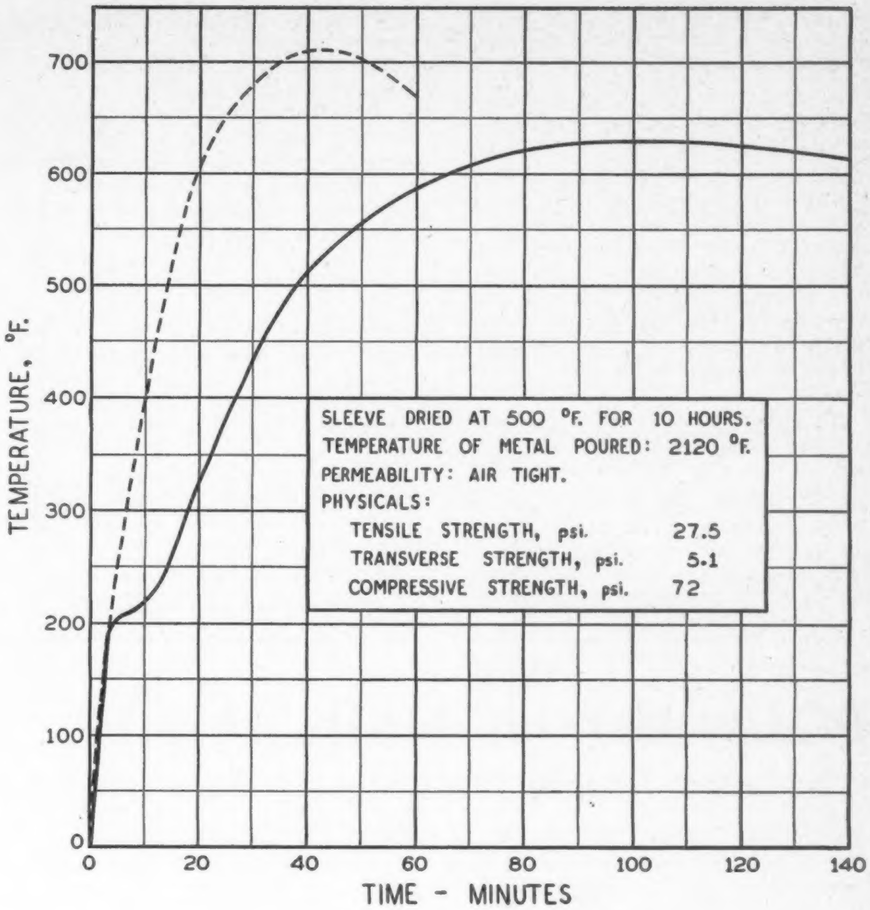


Fig. 17—Graph showing temperature rise of gypsum sleeve after pouring of casting.

Summary and Conclusions

In conclusion, the following observations are listed:

a. Comparing the relative efficiency of knock-off risers in both the ferrous and non-ferrous divisions of founding, it is stated that a greater number of sound castings (completely free from remnant shrinkage in necks) as well as easier knock-off of risers is obtained with non-ferrous castings.

b. Perforated metal screens and graphitic carbon disks effect distinct economies in the cleaning of brass and bronze castings.

c. Perforated metal screens and graphitic carbon disks do not disadvantageously affect the feeding of risers.

d. Perforated metal screens function best in brass risers not in excess of 5-in. diameter.

e. Graphitic carbon disks function with equal effectiveness in both brass and bronze risers, and in all sizes of risers.

f. Highest economies are realized when the number of castings is large or when the risers themselves are large.

g. For the same amount of feeding, gypsum sleeves enable the use of risers approximately 30 per cent smaller than conventional gravity-feed type risers.

DISCUSSION

Chairman: G. K. DREHER, Ampco Metal, Inc., Milwaukee.

A. MOST[1]: In using the iron screen, is there any danger of iron contamination of bronzes from the molten bronzes contacting the iron screen?

MR. BRINSON: None at all. The screen is sheet steel with a tin coating. We had an experience in that connection with a steel casting at one time. In closing the mold the molder used two pieces of tinned sheet steel to stop off a fin by chilling and keeping the metal from going into the mold. He inserted them a little too far and got them into the casting cavity about an inch. This was a large casting, weighing about 25,000 lb. as poured. After it was poured, we pulled the sheet metal out of the steel casting. Volatilization of the tin formed a cushion around the sheets and kept the casting metal from contacting the tinned sheet steel.

CHAIRMAN DREHER: You do peel the sheet metal off the risers and throw it away when you are through with it. You do not let it contaminate the back scrap.

MR. BRINSON: No, we remove it immediately.

GEORGE DALBEY[2]: We tried the perforated sheet on manganese bronze and we could not knock the riser off. We believed it was alloyed with the sheet and we took some of that same sheet and detinned it with acid and tried it again and had no difficulty.

MR. BRINSON: I can not offer a reason for that. We have been using it daily for over a year and never had trouble. We wanted to show the riser before and as it was knocked off, but we could not do it because the riser was knocked off as it came out of the mold.

CHAIRMAN DREHER: I think, Mr. Dalbey, that you could use the screen without the tinning, just as an ordinary piece of steel. It has been used successfully in that manner.

MR. BRINSON: The steel comes tinned. Detinning is an added expense.

CHAIRMAN DREHER: The important point is that it seems to work both ways.

LT. COM. B. O. BROUK[3]: I would like to ask Mr. Brinson what results he had

[1]Parkway Foundry & Machine Co., Brooklyn.

[2]U. S. Navy Yard, Mare Island, California.
[3]Bureau of Ships, Washington, D. C.

with the use of the tinned screen in connection with G-metal? Did you encounter an adverse condition?

Mr. Brinson: We were unable to knock the riser off and and that is what we were after.

Mr. Duma: The difficulty we had was that the risers stuck right to the screen. The union between screens and cast metal was so strong that no amount of hand hammering could flog the risers off. It appears that high tin (over 2 per cent) copper-tin alloys wet the surface of iron screens by tinning them and then alloy with the iron at the iron-tin interface.

Mr. Brinson: In some cases we have used two sheets, one on top of the other, and still were able to knock the riser off.

E. D. Boyle[4]: Mr. Brinson made the statement that one investigator was working on the problem of gas pressures. That is exactly what we are doing. Within the next two years we may have sufficient data on gas contamination of risers creating pressure.

Mr. Brinson: That is one of the problems we have to solve.

H. F. Taylor[5]: I wonder if Mr. Myskowski, who did the pioneer development and experimental work on the uses of the screen, would comment with regard to the oxidation of the screens for use with tin bronzes?

E. T. Myskowski[6]: It works satisfactorily.

Mr. Taylor: Did you find any improvement when you put on an oxide layer rather than a layer of tin, for example?

Mr. Myskowski: It seemed to work very well; it did not tend to stick as much.

Mr. Taylor: I think it may be tied up with a wetting condition. Whether it sticks or does not stick might depend upon whether the metal wets, or possibly alloys with, the coating.

[4]Puget Sound Navy Yard, Bremerton, Wash.

[5]Massachusetts Institute of Technology, Cambridge, Mass.

[6]Naval Research Laboratory, Washington, D. C.

FOUNDRY CONSULTANT

Retires From National Founders

Retirement of Gottfrid Olson, since 1936 foundry engineer, National Founders Association, Chicago, and appointment of David G. Anderson as consulting foundry engineeer, succeeding Mr. Olson, have been announced by the association.

Mr. Olson, a native of Sweden, where he was born in 1881, left immediately for Stockholm. He will remain there for a year, vacationing and doing special foundry work.

Entering the foundry industry at the age of 14, Mr. Olson served a seven-year apprenticeship; after which he worked as a journeyman molder for a time, then entered the Falu Berga Skola (Government School of Mines), from which he graduated in 1908.

After many years experience in this country (he came to America under Swedish government sponsorship in 1908) and in Sweden, he joined the National Founders Association in 1936.

A member of A.F.A. since 1926, he has been active in the Chicago chapter. Earlier, in 1918, he joined the Chicago Foundrymen's Club, served as its president in 1932, and retained his affiliation with the group after it became the first A.F.A. chapter in 1934.

Author of *Short Term Training in the Foundry* and several training pamphlets, Mr. Olson prepared many technical papers for A.F.A. conventions and chapter meetings.

In replacing Mr. Olson, David G. Anderson brings to the Association a background of forty years of continuous association with the foundry industry. Recently foundry engineer, General Electric Co., Chicago, with which firm he was associated for twenty years, he was previously affiliated with Ohio Malleable Iron Co., Columbus, Ohio, and the Pittsburgh Engineering Co., Pittsburgh, as foreman and general superintendent, respectively.

D. G. Anderson

Gottfrid Olson

Mr. Anderson is a member of A.F.A., was a member of the Chicago Foundrymen's Club and served as president of that group. He also holds membership in ASM and the Telephone Pioneers of America. Originator of a number of patents pertaining to the foundry industry, Mr. Anderson has presented numerous technical papers before engineering societies and universities.

Can You Help?

A.F.A. is anxious to obtain some copies of A.F.A. Transactions, Volumes 40 (1932) and 42 (1934) from members who may have no use for copies in their files. The supply of these volumes are entirely exhausted, and a number of important requests have been received for the above editions.

For intact copies in good condition A.F.A. will be glad to make arrangements for purchase. If you have a copy of Volume 40 or 42 which you do not need, please forward promptly to: The Secretary, American Foundrymen's Association, 222 W. Adams Street, Chicago 6, Ill.

Detroit in '47

(Continued from Page 23)

are excellent assurances of a hitherto unequalled 100 per cent, technical meeting.

In accordance with a recent action of the A.F.A. Board of Directors and a procedure agreed to by the Association's divisional executive committees, all papers to be presented at the technical and other sessions of the Detroit meeting will be approved and in the National Office for preprinting on or before January 15. If this program is adhered to strictly, preprints will be made available to the membership within a month prior to the Detroit sessions. Wide distribution of preprints will be reflected in more thoroughgoing discussion of the subject matter presented and in a more instructive, practical and comprehensive foundry congress.

The program of technical sessions, general meetings, symposia, round tables, committee meetings, shop sessions and other features of the Association's fifty-first convention will develop rapidly within the next few months and subsequent issues of American Foundryman will present information in detail.

CORE SAND

PURCHASING FACTORS

H. Louette
A. E. Murton
and
H. H. Fairfield

Two SANDS of widely different properties were investigated in the course of testing core sands for foundry use. Since the test data indicated some of the important properties which should be considered when purchasing core sand, it was thought that the results of the investigation might be of general interest.

The purpose of the investigation was to determine which of two sands was best suited for the production of radiator cores. Figure 1 shows the type of core made. This core is made on a bench. One half is rammed in a core box, and the other half is rammed in a drier. The two halves are "booked" together and the corebox is removed. The drier containing the completed core is placed on the oven rack.

Laboratory Tests on Sand Samples "As Received." The two sands were compared by mixing them with 1 per cent of bentonite, 1 per cent of cereal flour, and 1 per cent of core oil. The optimum water content for each sand was determined by test. The results obtained are shown in Table 1. Screen analyses of the two sands are given in Table 2 and Fig. 2.

Foundry Tests on Samples "As Received." The foundry test consisted of making 64 radiator cores with each type of sand. Details of this test are given in Table 3.

Preliminary Conclusions. From the laboratory tests it was evident that sand No. 1 would give baked tensile strengths three times as great as sand No. 2 with similar core sand mixtures. The foundry tests were not conclusive because the mixtures tested had different baked transverse strengths. Further test work was considered advisable in order to determine why No. 2 sand seemed to be a "better working" sand.

Laboratory Tests on Treated Samples. At this stage of the investigation it was thought that the difference in baked strength between the two sands was due to the difference in grain size distribution (Fig. 2). In order to test this idea, sand No. 2 was carefully screened to the same grain size distribution as sand No. 1. Tests were carried out on the treated sand, and the results are shown in Table 4.

Specification of grain size only in purchasing core sand is not a sufficient precaution to ensure that a suitable sand will be obtained. The pronounced effect of grain shape upon many of the properties of core sand mixtures is shown by tests. The rounded sand grain has many advantages over the angularly shaped grain, including lower core oil consumption, easier coremaking operations, and less gas and smoke in the foundry.

Shape of Sand Grains. Photomicrographs of the two types of sand are shown in Figs. 3 and 4. It will be noted that sand No. 1 had a smooth, rounded grain, and sand No. 2 a rough, subangular to angular grain. These grains are referred to as "rounded" and "angular" in this paper.

Foundry Tests on No. 1 Sand at Different Oil Ratios. A series of

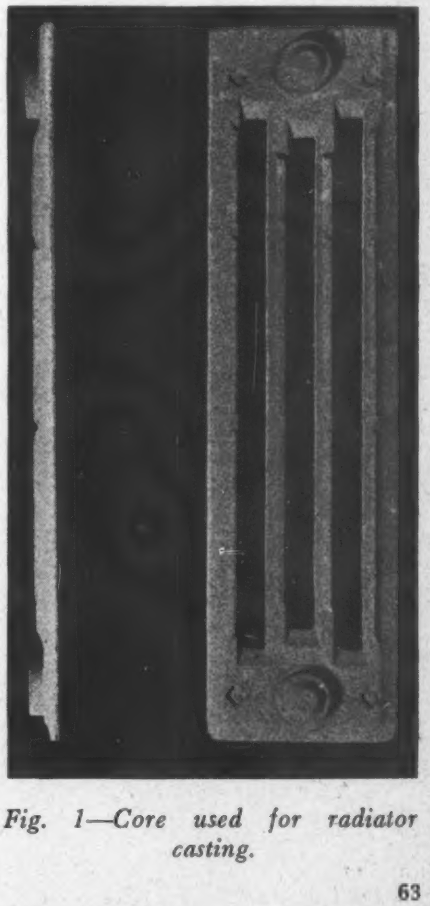


Fig. 1—Core used for radiator casting.

*Factory Superintendent, Warden King Ltd. (Div. of Crane Ltd.), Montreal, Que., Canada.

†Metallurgical Engineers, Bureau of Mines, Ottawa, Ont., Canada.

Presented at a Sand Shop Course Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 9, 1946.

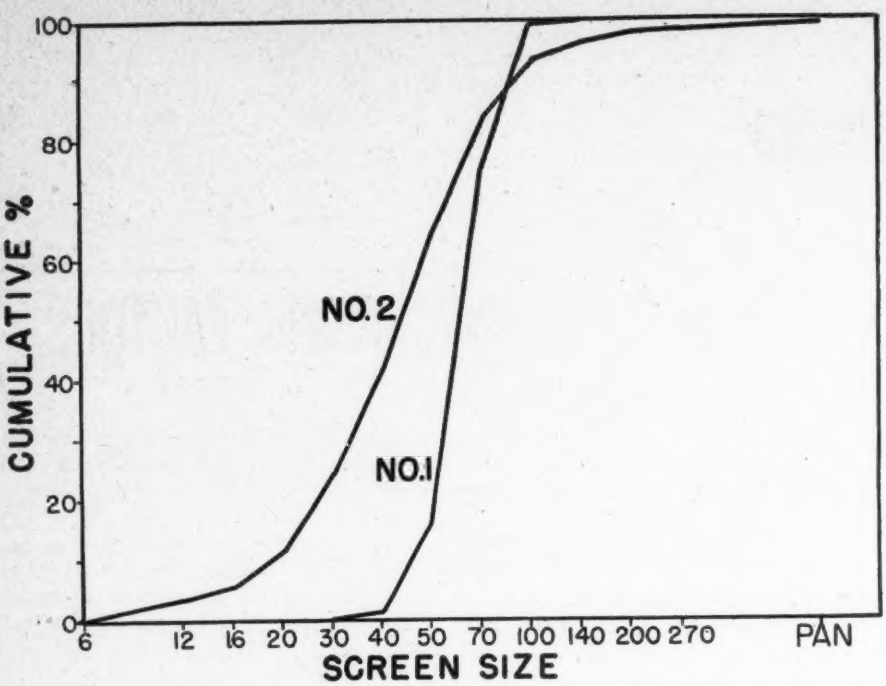


Fig. 2—Chart showing screen analysis of No. 1 (rounded grain) and No. 2 (angular grain) sands.

Table 1

Comparison of Core Sands

	No. 1 Sand	No. 2 Sand
Moisture required to temper, %	1.3	3.0
Green permeability	156	173
Green bond, psi.	2.6	2.6
Deformation, in. per in.	0.0175	0.0155
Flowability, %	88.5	84.0
Baked permeability	178	235
Baked tensile strength, psi	164.5	54
Core hardness	55	38
Hot strength at 2200° F., psi.	10	14
Hot strength at 2300° F., psi.	8	4
Hot strength at 2400° F., psi.	7	3

Table 2

Grain Size Distribution

U. S. Screen No.	Retained, % No. 1 Sand	Retained, % No. 2 Sand	Cumulative, % No. 1 Sand	Cumulative, % No. 2 Sand
6	0.0	0.2	0.0	0.2
12	0.0	3.2	0.0	3.4
16	0.0	2.4	0.0	5.8
20	0.05	5.9	0.05	11.7
30	0.05	12.8	0.1	24.5
40	1.2	17.9	1.3	42.4
50	14.9	22.1	16.2	64.5
70	59.2	18.7	75.4	83.2
100	24.0	9.6	99.4	92.8
140	0.4	3.0	99.8	95.8
200	trace	1.3	99.8	97.2
270	trace	0.6	99.8	97.8
Pan	trace	1.0	99.9	98.8
A.F.A. Clay	0.1	1.0	100.0	99.8
A.F.A. Fineness No.	49	43		

sand mixtures using sand No. 1 were prepared. The relationship of the core oil content to the baked transverse strength is shown in Table 5.

Cores made with a 170:1 sand-oil ratio gave excellent results in the coreroom and in the foundry. The earlier difficulty experienced with sand No. 1 was attributed to the fact that it was used in mixtures with a higher transverse strength than was desirable. In order to check the effect of transverse strength upon results in the foundry, the following tests were carried out. In these tests (Table 6) the No. 2 sand was screened so as to duplicate the grain size distribution of No. 1 sand.

Up to this time the core sand mixture used for radiator cores had consisted of No. 2 (angular) sand mixed with core oil in a ratio of 60:1. It was decided to conduct a trial run with No. 1 (rounded) sand mixed with core oil in a ratio of 170:1. After the experiment had been carried out for a three-week period, during which time 16,000 castings were made, the general conclusions were as follows:

(a) In comparison to cores previously used, the 170:1 core sand mixture produced much less gas. With the 60:1 core sand mixture, gas from the core vents spurted out into a pressure jet when the mold was poured. With the 170:1 mixture, only a small, lazy flame was noticeable at the vent after pouring. Workers noted the improvement in the foundry atmosphere.

(b) Coremakers reported that the low oil content core sand mixture resulted in cleaner coreboxes, easier coremaking, and less sticking

(c) In the casting cleaning operation, it was noted that the core sand ran freely out of the casting.

(d) The test core mixture gave a smoother casting finish.

(e) The low oil content core mixture required slightly closer control in baking.

Effect of Grain Shape. The work of Davies and Rees* showed that sand grain shape had a marked ef-

*W. Davies, and W. J. Rees, Paper No. 8/1944, Steel Castings Research Committee, Iron and Steel Institute; and "The Effect of Grain Shape on the Moulding Properties of Synthetic Moulding Sands," *Refractories Journal,* March, 1945, p. 98.

Table 3

TESTS OF SANDS "AS RECEIVED"

	Sand No. 1	*Sand No. 2*
Ratio of sand to oil (by weight)	81:1	59:1
Moisture, %	3.4	4.5
Baked transverse strength, lb.	45	34
Number of times core box needed cleaning	10	2
Time to make 64 cores, min	90	55
Coremakers' reports	"sticks to box" "hard to pack"	"better working sand"
Cores broken in removing from driers	none	5
Cores broken in cleaning and handling	3	1

fect upon molding and coremaking properties of sand mixtures. It was concluded that the difference observed between No. 1 (rounded) and No. 2 (angular) sand was due to the difference in sand grain shape.

In order to verify this conclusion, two sands were selected for practical test in the coreroom without consideration as to the grain fineness. The angular and the rounded sands were selected by microscopic observation (Figs. 5 and 6). These specimens were designated as No. 3 (rounded) and No. 4 (angular).

It was apparent from these tests that successful results in the coreroom were obtained with core mixtures which would develop a transverse strength of 25 to 35 lb. when baked (corresponding baked tensile strength is approximately 100 to 175 psi.).

High Baked Strength

Core mixtures with higher baked strengths gave trouble in the coreroom, both in ramming up cores and in removing cores from driers.

The difference between the foundry performances of No. 1 (rounded) and No. 2 (angular) sands is attributed to three conditions. First, the No. 2 sand had clay or other materials adhering to the grains. This was shown by the improvement attained by washing. Secondly, the grain size distribution of No. 2 sand was not as good as that of No. 1 sand. When the fine material was eliminated by screening, No. 2 sand showed better results. *The most important difference between the two sands, however, was that of grain shape.*

Grain Contact

Rounded grains pack together more easily than do angular grains. This enables the oil-coated grains to have better contact with each other. Better contact means higher baked tensile strength.

Rounded grains have a smaller surface area than do angular grains. The smaller surface area results in a thicker coating of oil on each grain; therefore, a higher baked strength is obtained with rounded-grain sand.

The areas of contact are larger with rounded grains than with sharp cornered angular grains. This also results in higher baked strength with rounded-grain sand.

Tests carried out with No. 3 and No. 4 sand served to verify the conclusions concerning the effect of grain shape. It was of considerable

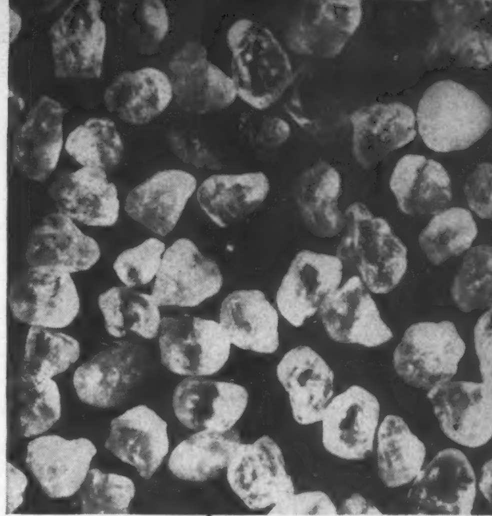


Figure 3
Photomicrograph of No. 1 sand showing smooth, rounded grain. 25X.

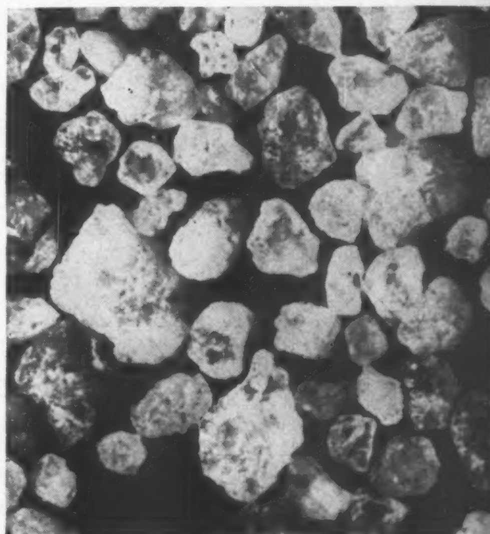
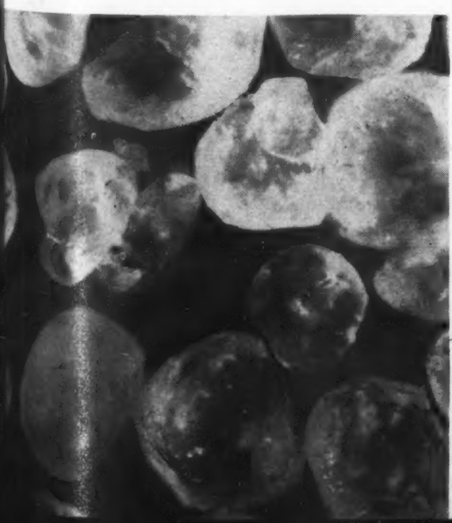


Figure 4
Sand No. 2 has rough, subangular to angular grain. 25X.



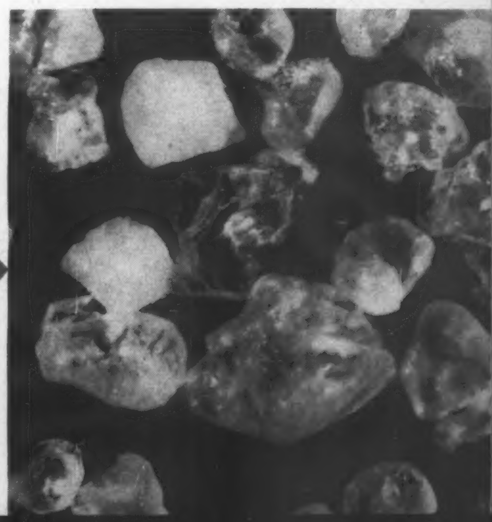


Figure 5
Left—No. 3 sand, rounded grain. 25X.
Right—No. 4 sand, angular grain. 25X.

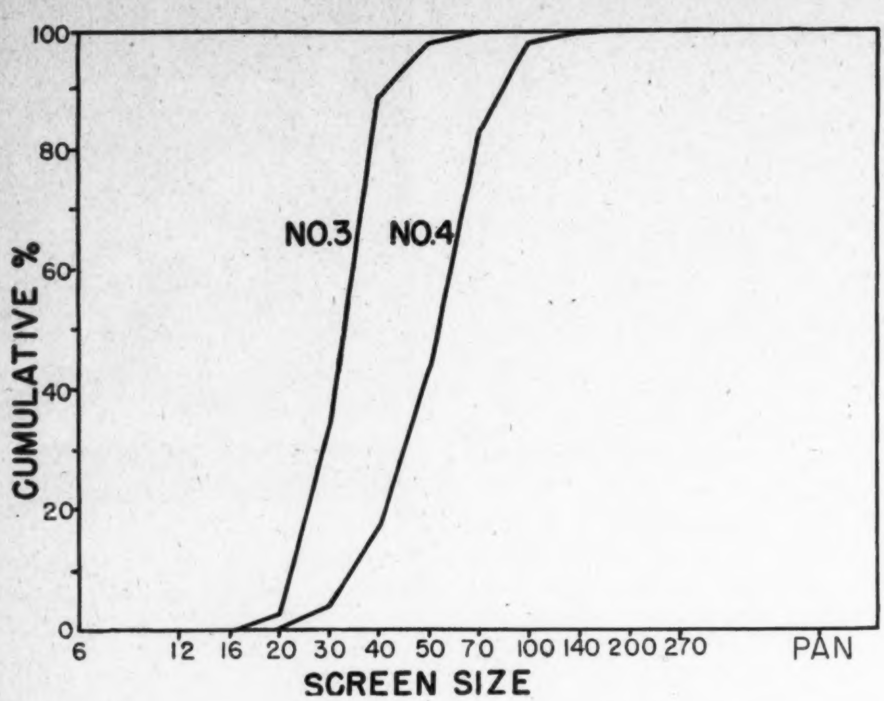


Fig. 6—Chart showing screen analysis of No. 3 (rounded grain) and No. 4 (angular grain) sands.

Table 4

TENSILE STRENGTH, SANDS NO. 1 AND 2

Description of Sample	Baked Tensile Strength, psi.
No. 1, as received	165
No. 2, as received	54
No. 2, washed only	82
No. 2, washed and screened to same grain size distribution as No. 1	107

Table 5

EFFECT OF OIL CONTENT ON TRANSVERSE STRENGTH OF NO. 1 SAND

Sand to Core Oil Ratio	Baked Transverse Strength, lb.
57:1	54
81:1	47
114:1	34
170:1	26

Table 6

TRANSVERSE STRENGTH TESTS

Sand to Core Oil Ratio	Sand Type	Transverse Strength, lb.	Results in Coreroom and Foundry
170:1	No. 1 (rounded)	23	Good.
170:1	No. 2 (angular)	None	All cores broke when removed from driers.
87:1	No. 1 (rounded)	46	Considerable difficulty in removing cores from driers.
87:1	No. 2 (angular)	20	Fair.

Table 7

SAND GRAIN SHAPE AND CASTING FINISH

	Core Sand	
	No. 3 (rounded)	No. 4 (angular)
Core sand to core oil ratio	170:1	170:1
Core hardness	65 to 70	nil
Transverse strength, lb.	24	8.5
A.F.A. Grain Fineness No.	27.5	47.5
Results in coreroom	Excellent	All cores broke when rapping out of driers
Finish on casting	Smooth	

interest to note that the sand with an A.F.A. Fineness of 27.5 gave a smooth casting, which could not be distinguished from one made with No. 1 and No. 2 sand (A.F.A. Fineness No. 40 to 50). It is apparent that the shape of the sand grains has considerable effect upon casting finish. (Table 7).

Conclusions

Previous to this project, when core sands were examined for foundry use the properties considered were:

1. Refractoriness.
2. A.F.A Grain Fineness.
3. Amount of clay, dirt, and foreign matter.
4. Grain size and distribution.

As a result of the tests reported in this paper, it was concluded that the shape of the sand grain has a profound influence upon the properties of core sand mixtures. Therefore, preference should be given to a sand with rounded, smooth-surfaced grains. A low-power microscope is a useful tool in estimating the suitability of core sands.

The authors are indebted to E. N. Delahunt, general superintendent, and E. Gervais, sand control supervisor, Warden King, Ltd., for their valuable cooperation in writing this paper. Warden King, Ltd., also wishes to express appreciation of the work carried out by the Physical Metallurgical Research Laboratories of the Bureau of Mines, Ottawa, Canada.

General Interest Group Completes Membership

ORGANIZATION of the A.F.A. Sand Shop Operation Course Committee has been completed, with D. F. Sawtelle, Malleable Iron Fittings Co., Branford, Conn., serving as Chairman and R. H. Jacoby, Key Co., East St. Louis, Ill., as Co-Chairman.

Other members are: F. S. Brewster, Dow Chemical Co., Bay City, Mich.; E. J. Bush, U. S. Navy Yard, Washington, D. C.; and F. R. Mason, Riley Stoker Co.; E. L. Thomas, Cadillac Motor Co.; and E. E. Woodliff, Foundry Sand Service Engineering Co., all of Detroit.

NATIONAL FOUNDERS
Association Holds Annual Convention

First post-war convention of the National Founders Association, Chicago, will take place at the Waldorf-Astoria Hotel, New York, November 7-8. According to advices from the association's national office, this 49th annual meeting promises to be the most successful.

Convening on the Starlight Roof Thursday morning, November 7, the gathering will hear an array of outstanding business and political speakers, who are expected to present valuable tips in discussions of business problems and political developments.

Report on Elections

Leading off the program, following the report of the association's president, H. Menck, Harnischfeger Corp., Milwaukee, will be C. B. Dickson, executive editor, Gannett News Service, Washington, D. C., who will analyze the results of Congressional elections.

Plans and suggestions for recreation activities of foundry workers will be presented by C. E. Brewer, National Recreation Association, Inc., New York.

Scheduled to analyze government and business relations, Stuart S. Ball, Montgomery Ward & Co., Chicago, discusses "The Balance of Power." "Trends in Collective Bargaining" is the subject of O. C. Cool, director, Labor Relations Institute, New York; while Gerald D. Reilly, retiring member of the Labor Relations Board, offers reasons for his proposed amendments to labor legislation.

Returning from England in time for the convention, R. G. LeTourneau, R. G. LeTourneau, Inc., Peoria, Ill., will incorporate first-hand and informative material into a discussion of "Business—Not as Usual."

Health Program

Dr. Harold A. Vonachen, Caterpillar Tractor Co., Peoria, Ill., who holds the Knudsen Award for his work in industrial hygiene and medicine, outlines to the founders a "Health and Safety Program to Promote Our Industry."

Other speakers are: DeLoss Walker, Chicago, "The How and Why of Foremanship," and Martin Dies, Lufkin, Texas, "The Growing Threat of Fellow Travelers."

Election of officers will take place Thursday afternoon. W. W. C. Ball, The Taylor & Fenn Co., Hartford, Conn., a member of the association's administrative council and chairman of the nominations committee, will present the recommendations of his group.

The conference will wind up Friday morning, November 8, following action on reports of the finance and resolutions committees, presented by the chairmen, respectively: I. R. Wagner, Electric Steel Castings Co., Indianapolis, and James L. Wick, Jr., Falcon Bronze Co., Youngstown, Ohio.

Popular Sand Courses Will Remain Informal

Four informal sessions, on steel, gray iron, malleable and non-ferrous practices, will be presented at the 1947 Convention in Detroit under sponsorship of the A.F.A. Sand Shop Operation Course Committee, that committee decided at its meeting of September 23, in the Statler Hotel, Detroit, Chairman D. F. Sawtelle, Malleable Iron Fittings Co., Branford, Conn., presiding.

Named as chairmen for the sessions were: steel, R. H. Jacoby, Key Co., East St. Louis, Ill.; gray iron, E. L. Thomas, Cadillac Motor Car Co., Detroit; malleable, D. F. Sawtelle, and, non-ferrous, E. J. Bush, U. S. Navy Yard, Washington, D. C.

The popular informality of the meetings—with no stenotypist present and discussors not required to give their name or company affiliation—will be continued. Prepared papers will not be required; the discussion leader will introduce the subject with a talk of 15 to twenty minutes, to raise discussion.

Meetings will be in charge of a chairman, co-chairman and a discussion leader. A number of outstanding foundrymen were suggested for the latter two capacities at the sessions; and chairmen will announce appointments in the near future.

An interesting aspect of the meetings, that of relative attendance at evening and daytime sessions, was considered by the committee, which remained on record as in favor of the former.

Also drawing attention of the committee members was the question of publicity directed specifically to local foundries, in order to acquaint their employees with the advantages of the informal gatherings. This step was considered of prime importance, and plans were laid to reach foundries in the Convention area with an explanation of the courses, their purpose and schedule.

Revise Authors' Guide On Papers Preparation

Suggestions for the preparation and presentation of technical papers are given in the revised and expanded Guide to Authors, recently published by the American Foundrymen's Association. Emphasizing the significance of publication and distribution of information by a technical society, the booklet presents instructions or the preparation of manuscripts, drawings, photographs, slides and tables, and examples of the proper form for references and footnotes.

Illustrations, not used in previous editions include full scale reproductions of standard types of hand lettering and the same lettering after reduction for printing. Full scale and reduced line sizes are shown.

Announces Membership Of Gray Iron Committe

Appointments to the Analysis of Casting Defects Committee, A.F.A. Gray Iron Division, have been announced by Division Chairman T. E. Eagan, Cooper-Bessemer Corp., Grove City, Pa.

W. A. Hambley, Slinger Foundry Co., Slinger, Wis., has been named Chairman and W. B. McFerrin, Electro Metallurgical Co., Detroit, Co-Chairman.

Other members are: G. W. Anselman, Goebig Mineral Supply Co., Chicago; T. E. Barlow, Battelle Memorial Institute, Columbus, Ohio; A. S. Klopf, Lester B. Knight & Associates, Chicago; F. L. Overstreet, Illinois Clay Products Co., Chicago, and Charles Zahn, Vilter Mfg. Co., Milwaukee.

GRAY IRON CASTINGS

SECTION SENSITIVITY

Henry C. Winte
Worthington Pump & Machinery Corp.
Buffalo, N. Y.

Most foundrymen are familiar with the fact that cast irons of low carbon and silicon contents must be used to obtain high strength, close grained metal in heavy sections. Through experience, they have learned that section size is a variable which affects the tensile strength and hardness of cast irons.

Experimental data published in recent years show that the physical properties of cast iron in test bars are decreased by increasing the section size of the bars. The loss in strength indicates the section sensitivity of the iron. The effect of the total carbon plus ⅓ Si ratio (carbon equivalent) upon the strength and hardness of cast iron as the section size increases has been investigated.

Section Size

In increasing section size, the factor which causes a decrease in the physical properties is the decreased cooling rate. Cooling rates depend upon a number of factors, such as temperature of the iron at pouring, rate of pouring, volume of metal to be cooled, metal surface area for transfer of heat to the sand, conductivity of the mold material, cores, energy releases, number of castings in the mold, amount of sand surrounding the casting, and the position of gates and risers.

The rate at which the metal cools in the mold affects the amount and size of the graphite flakes, the pearlite grain size, and the structural condition of the matrix. With slower cooling, more time is allowed for the graphite to precipitate and grow larger, thus causing a decrease in strength because of the weakness of the graphite. Also, slower cooling allows more pearlite to break down into ferrite, thereby decreasing the strength because ferrite is weaker than pearlite.

Iron Strength

The strength of the iron in a casting will be the same as that of a certain test bar only when the cooling rate of the casting is the same as that of the test bar. The graph in Fig. 1 shows the relation between section size and tensile strength of cast iron. Selection of the proper iron to meet design requirements is of basic importance.

Design engineers may accomplish this by use of the data graphically shown in Fig. 1. For example, a one in. diameter test bar may not have the same cooling rate as a casting having a one in. thick section.

Physical properties of a casting may be predicted from a test bar only when the cooling rate of the test bar is comparable to that of the casting. The relation between section size and tensile strength has been worked out in graphic form, enabling the engineer to select an iron which will meet design requirements of the casting.

Strength of Castings

Mathematical formulas have been developed for predicting the strength of castings, but they are applicable only to simple shapes. According to Bolton*, the volume of molten metal in the casting is proportional to the heat energy to be dissipated. The surface area of the casting is the exposed area from which the heat must be dissipated. Therefore, the cooling rate is directly related to the ratio of the volume in cu. in. to surface area in sq. in. $\frac{V}{A}$. The ratios for a number of bars and plates are shown in Table 1.

It is apparent from the table that a ½ in. diameter test bar will have the same cooling rate as a ¼-in. plate, and a 6 in. diameter test bar the same as a plate 4½ in. thick. In order to predict the strength of a casting it is evidently erroneous to select a test bar having a diameter about the same as that of the casting wall thickness.

In actual practice, casting shapes are seldom simple. In most cases, castings are round or square and contain cores to form the shape of the cavity. When these molds are poured, the core, being almost completely surrounded by metal, will be heated quicky by the molten metal and will retain the heat, since it has no avenue of escape except through the casting as it cools. This process

Presented at a Symposium on Engineering Properties of Gray Iron Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 8, 1946.

*John W. Bolton, *Gray Cast Iron*, Penton Publishing Co., Cleveland.

Table 1

Relation of Cooling Rate to Volume-Area Ratio

	Casting Size, in.					
	Diameter	*Square*	*Thickness*	*Length*	*Width*	$\frac{V}{A}$ *Ratio*
Bar	½			21		0.122
Bar		½		21		0.123
Plate			¼	12	12	0.120
Bar	1.2			21		0.290
Bar		1.2		21		0.290
Plate			⅝	12	12	0.286
Bar	2			22		0.488
Bar		2		22		0.476
Plate			1⅛	12	12	0.478
Bar	4			18		0.901
Bar		4		18		0.905
Plate			2 9/16	12	12	0.889
Bar	6			18		1.290
Bar		6		18		1.285
Plate			4½	12	12	1.285

greatly retards the cooling rate of the casting.

Three castings, poured of the same cast iron, were selected from actual practice to compare with test bars of various diameters. These castings were pistons having internal cores, but varying in wall thickness and mass. The engineer specified ASTM Class 35 as the cast iron to be used, because an iron having a tensile strength of 35,000 psi. was desired in the finished castings. The foundry estimated that the ASTM Class 35 iron would not give the required tensile strength in the casting and poured from an ASTM Class 45 cast iron.

Figure 2 illustrates the effect of decreased cooling rate on the tensile strength and Brinell hardness of the Class 45 cast iron. By increasing the section size from ½-in. to 6-in. diameter, the tensile strength and Brinell hardness decreased 57 per cent.

Figure 3 illustrates the effect of decreased cooling rate on the graphitic structure. The graphite increases in amount and size with a corresponding decrease in physical properties.

The effect of the decreased cooling rate on the structure of the matrix is shown in Fig. 4. The pearlite grows coarser until finally some free ferrite is precipitated, causing the strength and hardness to decrease.

Piston Specifications

A diesel engine piston, shown in Fig. 5, weighs 980 lb. and five are cast in a dry sand mold. The sections are ½ in. except the wrist pin bosses, ribs and top, which are approximately one in. thick. The piston is cast with ¼-in. finish. A drawing of this casting is shown in Fig. 6. The metal has a tensile strength of 34,100 psi. and Bhn. of 185 at the position shown in Fig. 6.

Although the sections vary from ¾ to 1¼ in., the actual cooling rate is comparable to a 2½ in. diameter test bar. Referring to Fig. 2, a tensile strength of 34,100 psi. is seen to correspond to a cooling rate corresponding with a 2½ in. diameter test bar. This fact is further confirmed by the Brinell hardness. The actual Brinell hardness

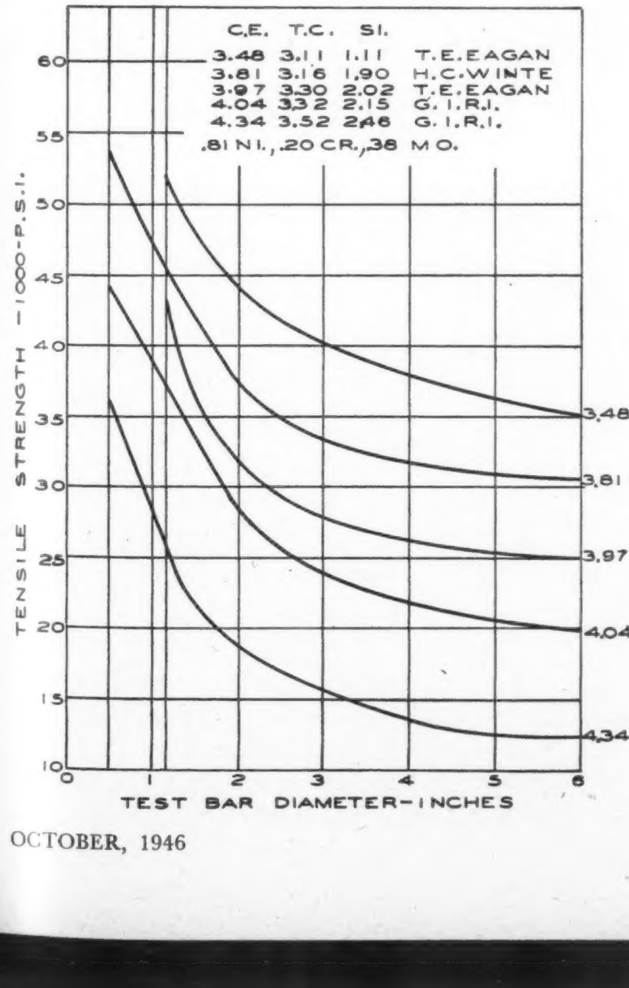
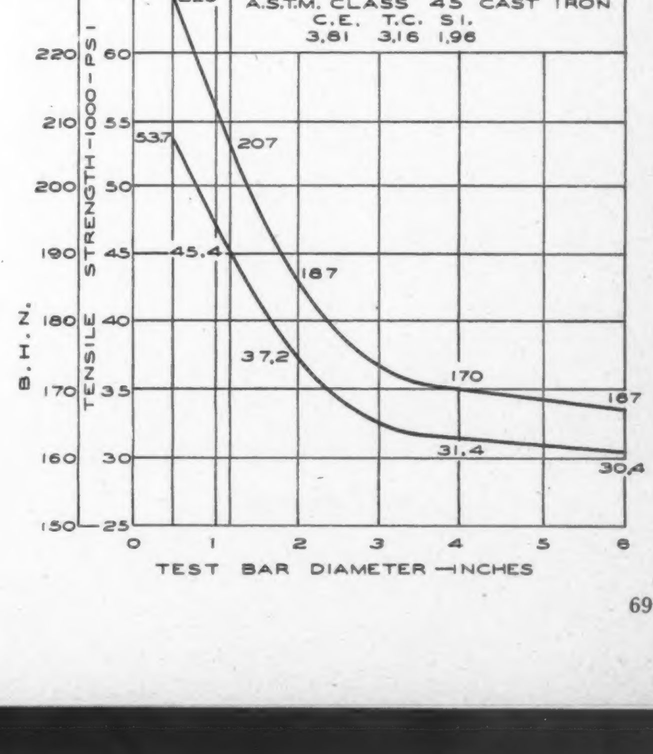
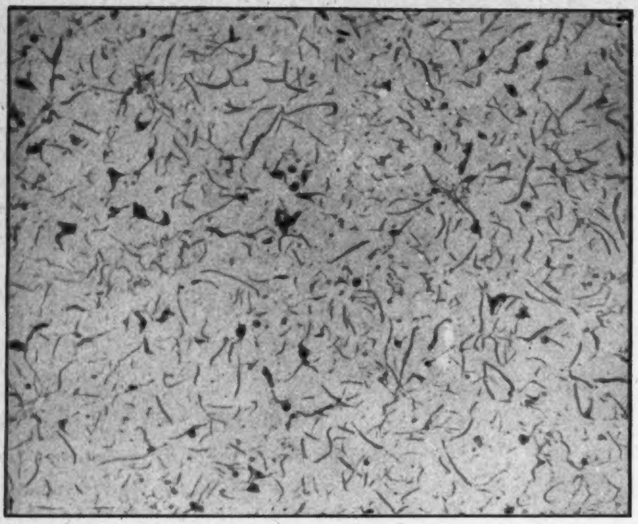


Fig. 1 (left)—Graph showing effect of section size on tensile strength of cast iron in test bars.

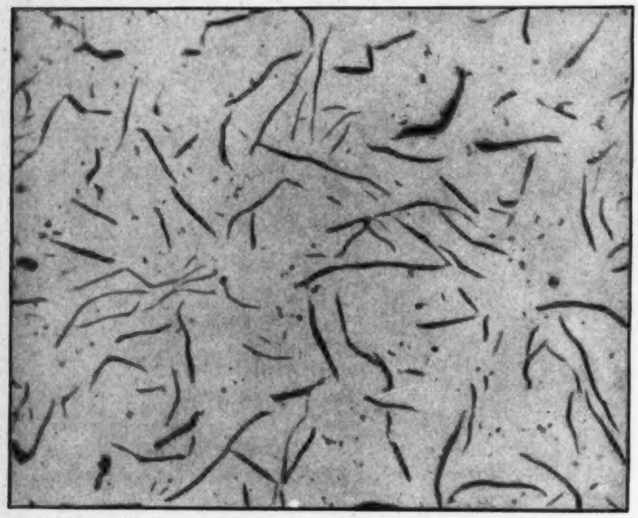
Fig. 2 (below)—Effect of section size on tensile strength and hardness of ASTM Class 45 cast iron.



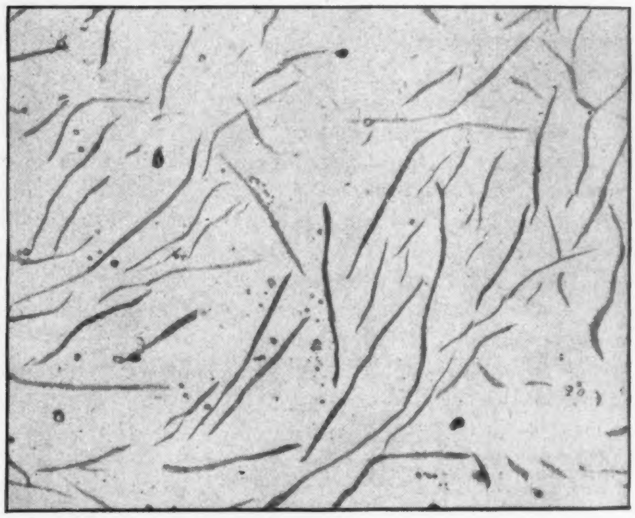


½ in. Diameter Bar

1.2 in. Diameter Bar



2 in. Diameter Bar



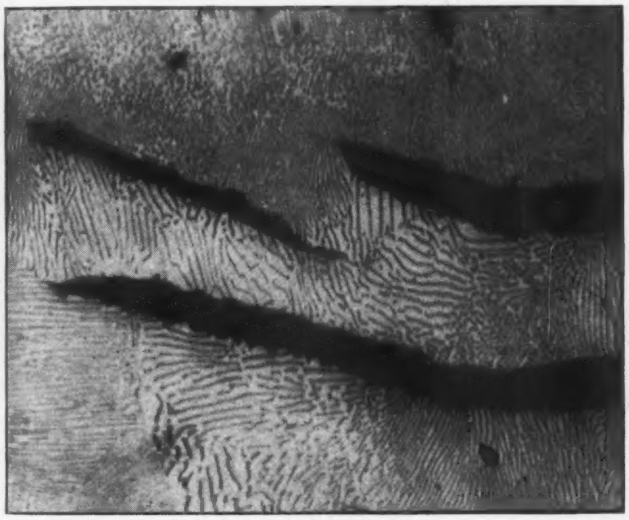
4 in. Diameter Bar

6 in. Diameter Bar

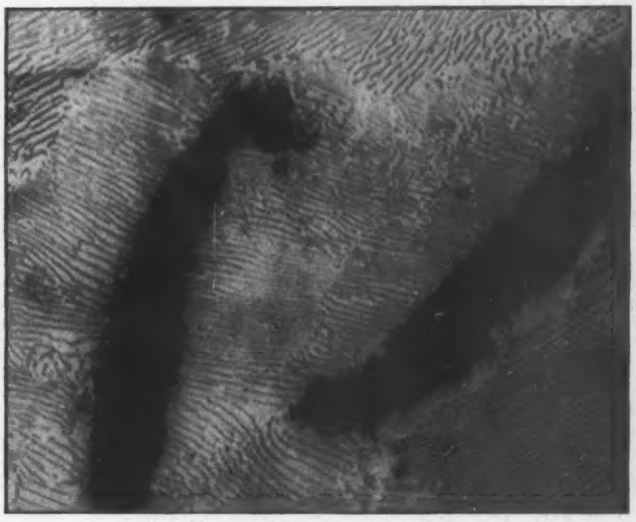
Fig. 3—Photomicrographs showing effect of decreased cooling rate upon graphite in cast iron test bars of various diameters. Unetched. 100X.

½ in. Diameter Bar

1.2 in. Diameter Bar

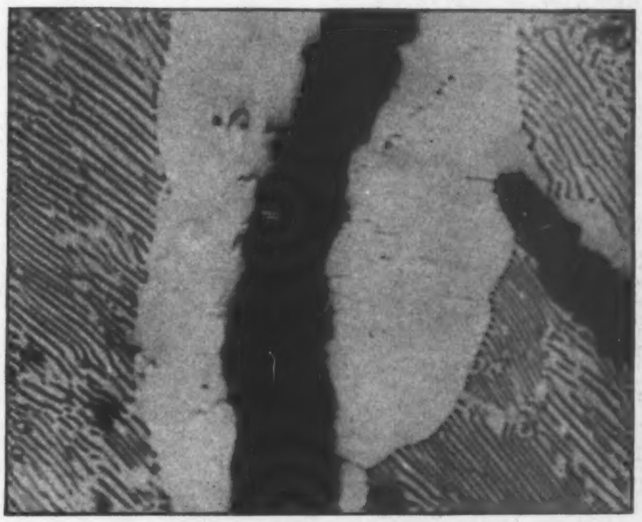


2 in. Diameter Bar



4 in. Diameter Bar

Fig. 4—Photomicrographs showing effect of decreased cooling rate upon pearlitic structure of cast iron test bars of various diameters. Etched. 1000X.



6 in. Diameter Bar

Table 2

CHEMICAL ANALYSES AND PHYSICAL PROPERTIES

Casting	*Carbon Equivalent*	*T.C.*	*Si*	*Tensile Section, in.*	*Tensile Strength, psi.*	*Bhn.*	*Casting Weight, lb.*
Diesel Piston	3.72	3.00	2.13	¾	34,100	185	980
Ammonia Compressor Piston	3.84	3.18	1.98	7/16	33,475	192	30
Air Compressor Piston	3.71	3.17	1.67	3¼ boss	32,760	179	160
				⅞ boss	30,875	179	

of 185 is close to the indicated hardness of 180 in the test bar.

An ammonia compressor piston, shown in Fig. 7, weighs 30 lb. and four are cast in a green sand mold. The section size varies from 5/16 to ⅝ in., with ⅛-in. finish. A drawing of this piston is shown in Fig. 8. A tensile bar was cut from a 7/16-in. section, as shown in Fig. 8. The tensile strength was 33,475 psi. and Brinell hardness 192.

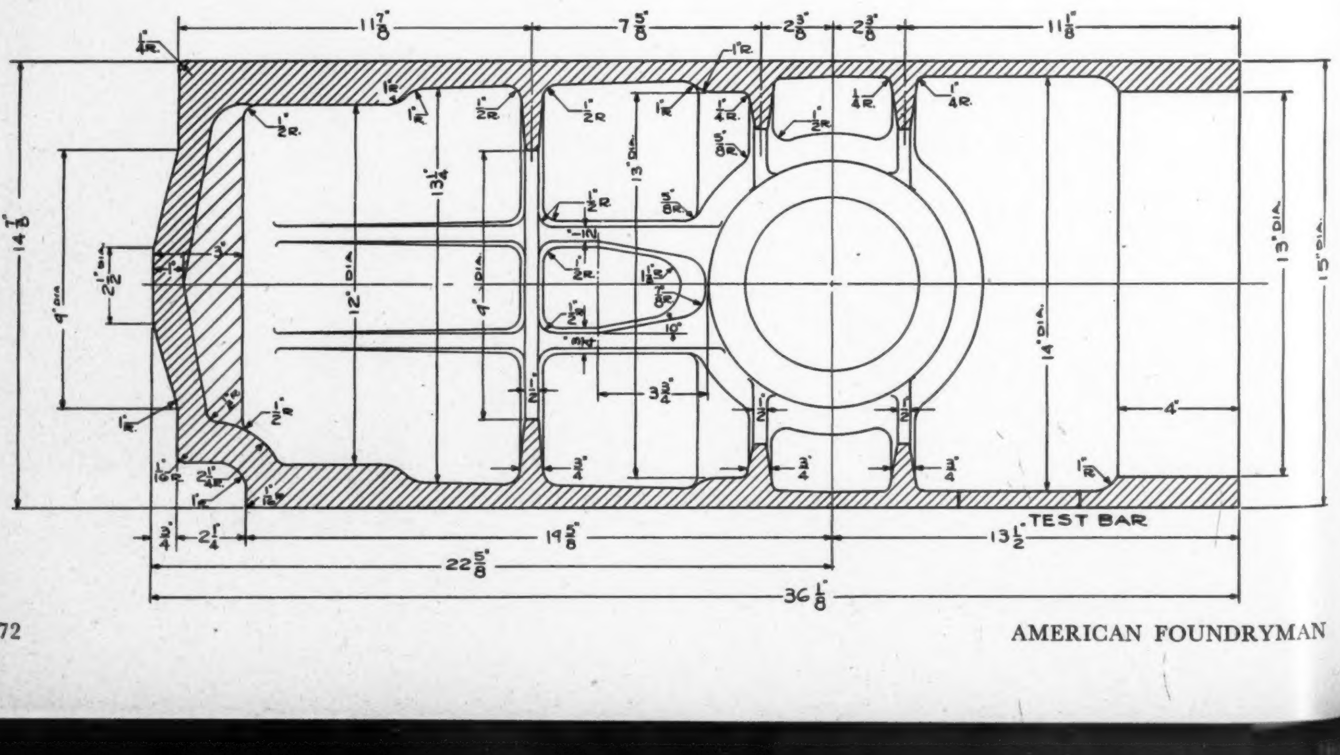
The actual cooling rate of the casting is comparable to that of a 2½-in. bar since, as illustrated in Fig. 2, the 33,475 psi. tensile strength is comparable to the cooling rate of a 2½ in. diameter test bar. Also, the Brinell hardness of 192 again compares favorably with the indicated figure of 180. Figure 9 is a photomicrograph of the test piece, which also indicates a slower cooling rate than that of a 7/16 in. diameter test bar.

An air compressor piston, shown in Fig. 10, weighs 160 lb. and is cast singly in a green sand mold. The section size varies from ⅝ in. to 3¼ in. at the center boss for the piston rod. This boss is cast solid, as illustrated in Fig. 11. Tensile specimens were taken from the ⅞-in. section, and the 3¼-in. boss, as shown in Fig. 11. One-quarter in. is allowed for finish on the casting.

The ⅝-in. section had a tensile strength of 30,875 psi. and 179 Brinell hardness; the 3¼-in. section

Fig. 5 (above)—Diesel engine piston casting.

Fig. 6 (below)—Cross-sectional drawing of deisel engine piston.



a tensile strength of 32,760 psi. and 179 Brinell hardness. The results are comparable since they are within the limits of error when testing a small-diameter specimen.

The cooling rate of the casting was comparable to that of a 3½ in. diameter test bar for, as shown in Fig. 2, the tensile strength is approximately that of a 3½ in. diameter test bar. This cooling rate is also substantiated by the actual Brinell hardness. The piston had a hardness of 179 as compared with a Brinell hardness of 173 in the 3½ in. diameter bars. The fact that the ⅝-in. section had a slower cooling rate than a test bar of the same size is also indicated in Fig. 12 by the size of the graphite and pearlite structures.

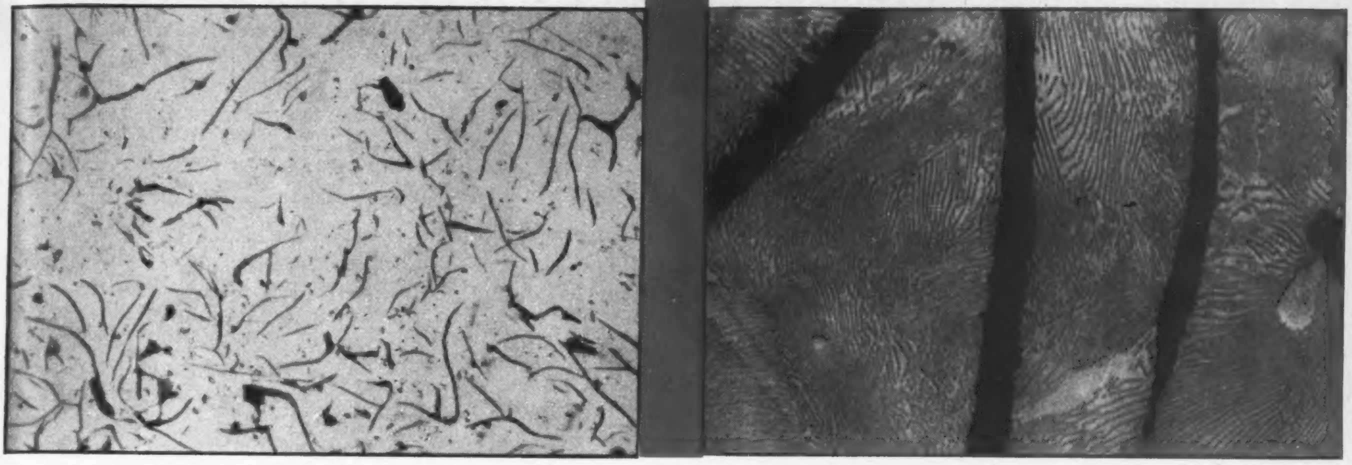
Table 2 shows the chemical analyses and physical properties of each of the castings. Although there is some variation in the chemical analysis, the T.C. plus ⅓ Si (carbon equivalent) is within the specification limits for this iron.

Conclusions

1. A test bar can be used to predict the physical properties of a casting only when the cooling rate of the test bar is comparable to the cooling rate of the casting.

2. To predict the strength of a given casting, the volume-area ratio can be used to compare the cooling rate of a test bar and the casting.

3. The cooling rate of castings is affected by internal cores. Under these conditions, it is not possible



Graphite, unetched. 100X. Pearlite, etched. 1000X.

Fig. 9—Photomicrographs showing graphite and pearlitic structure of cast iron used for ammonia compressor piston.

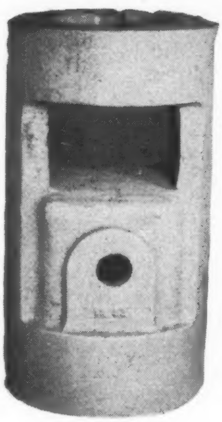
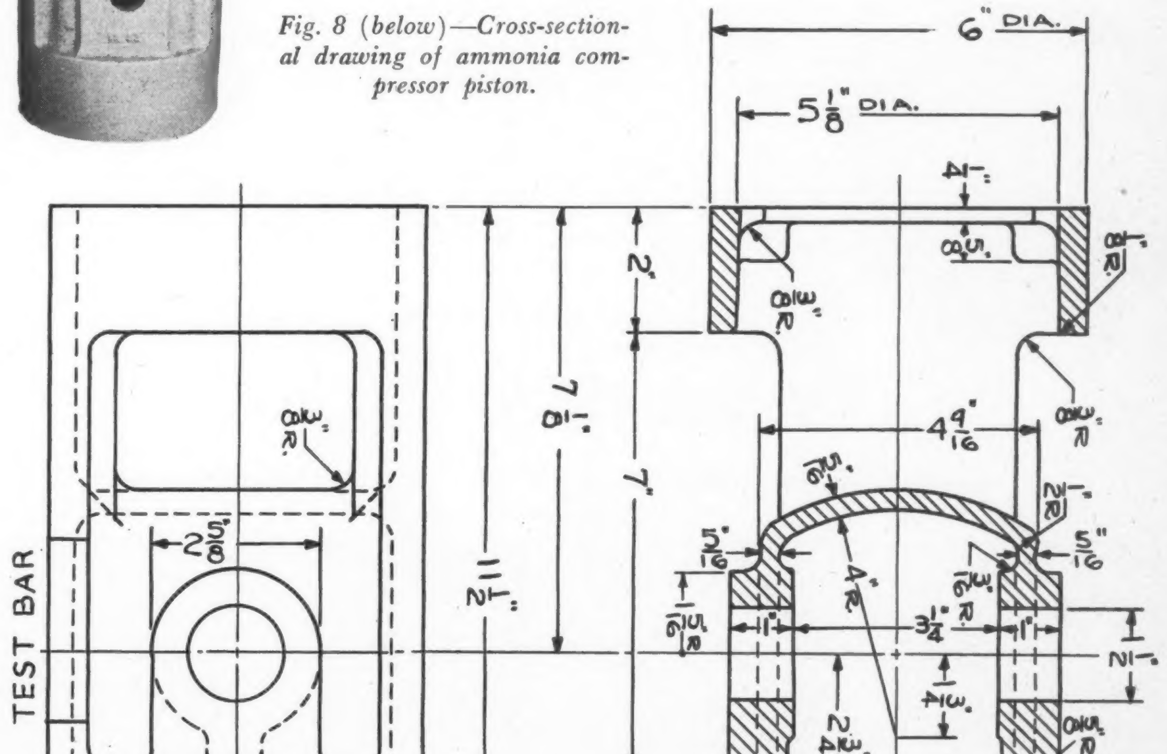


Fig. 7 (left)—Ammonia compressor piston casting.

Fig. 8 (below)—Cross-sectional drawing of ammonia compressor piston.



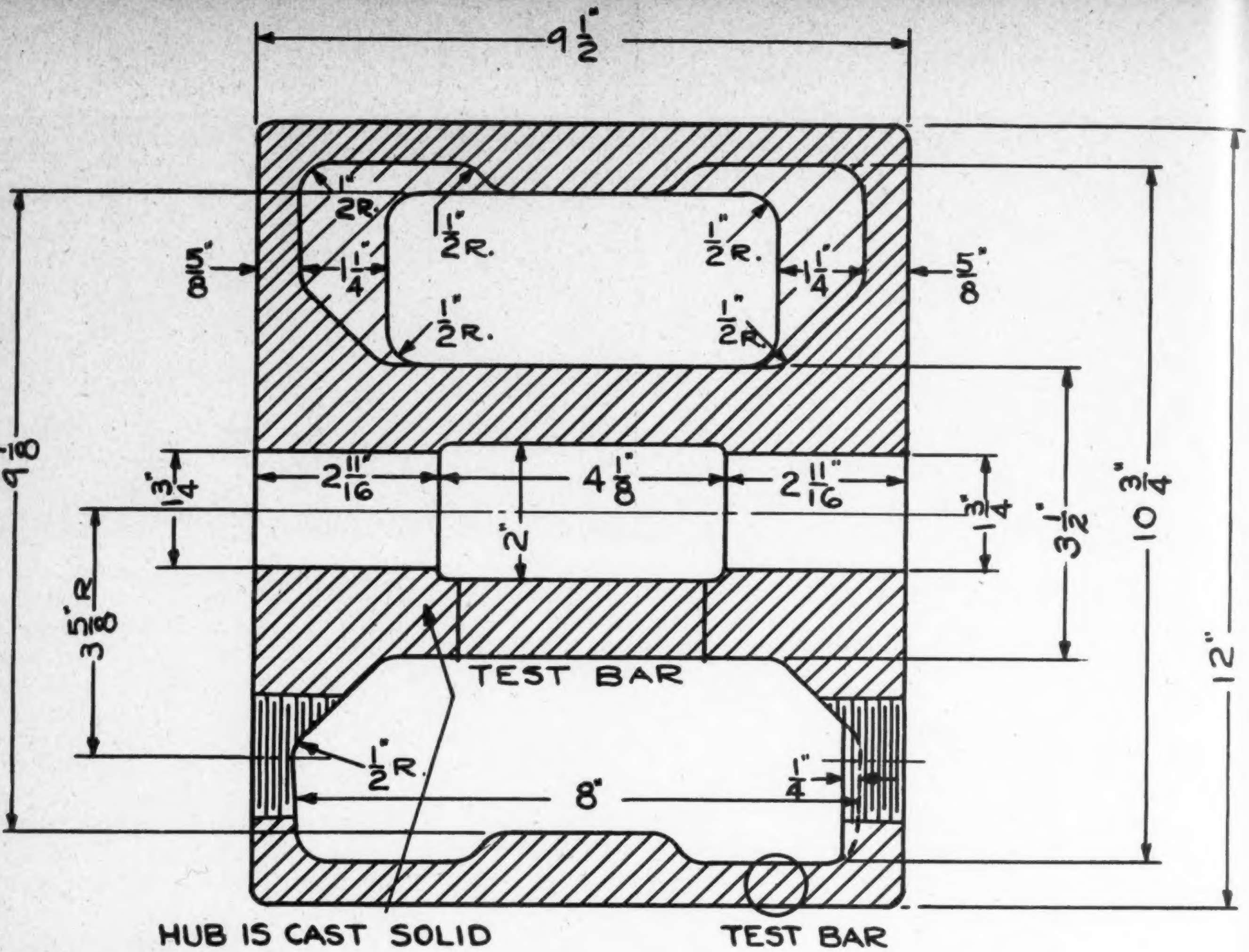


Fig. 11 (above)—Cross-sectional drawing of air compressor piston.

Fig. 10 (left)—Air compressor piston casting.

Fig. 12—Photomicrographs showing graphite and pearlitic structure of cast iron used for air compressor piston.

Graphite, unetched. 100X. **Pearlite, etched. 1000X.**

to predict the casting strength. A close estimate is possible by using either a 2 in. or 3 in. diameter test bar, or an appropriate precentage of the strength of the 1.2 in. diameter test bar.

4. Foundries should investigate the effect of section size on each iron poured so as to establish its section sensitivity.

Acknowledgments

Grateful acknowledgment is made to the following men for their welcome suggestions and cooperation in the preparation of this paper: J. C. DeHaven and D. E. Krause, Gray Iron Research Institute, Columbus, Ohio; T. E. Eagan, Cooper-Bessemer Corp., Grove City, Pa.; R. J. Allen, Worthington Pump & Machinery Corp., Harrison, N. J.; R. G. McElwee, Vanadium Corp. of America, Detroit; and Fred J. Walls, International Nickel Co., Detroit.

DISCUSSION

Chairman: R. G. McElwee, Vanadium Corp. of America, Detroit, Michigan.
Co-chairman: W. E. Mahin, Armour Research Foundation, Illinois Institute of Technology, Chicago, Illinois.

Chairman McElwee: Data in this paper checks some work that I have seen. I know of cases where arbitrary sizes of test bars have been established by experimentation to fit conditions of a peculiar type of casting so that the test part can be a pilot. I also know of test bars of add dimensions, such as 1½ in., being used because in a particular job which is a long run job, it had been found that it was necessary to establish that type of test bar to fit the casting under consideration. Of course, where you make single castings you do not have the opportunity to do that.

This paper is worth while because it demonstrates that these relationships do have some tendency to follow the laws that you would expect them to and that you can use test bars if you use them judiciously for control methods.

Association Publishes Lead Corrosion Study

General guide to the selection of materials in plant construction, with reference to economical employment of lead with various chemicals in process industries, is given a list of such chemicals and the reactions they may be expected to have with lead, in the July-August issue of *Lead,* published by Lead Industries Association, 420 Lexington Ave., New York.

December Deadline for 1947 Convention Papers

Technical papers for the 1947 Annual Convention of the American Foundrymen's Association are now being considered by the Association's seven technical divisions, in the fields of gray iron, cast steel, malleable iron, brass and bronze, aluminum and magnesium, patternmaking, and sand. General interest committees on apprentice and foreman training, safety and hygiene, plant equipment, engineering schools, foundry costs, castings inspection, refractories and job evaluation are also selecting convention papers.

Submit Papers Soon

Authors are urged to submit their papers as soon as possible, since none will be scheduled for the 1947 convention unless approved by the appropriate Program and Papers Committee prior to January 15, 1947. They must be submitted to a division review committee before December 15, 1946. Other features of the publication policy recently approved by the A.F.A. Board of Directors include preprinting and distribution of all convention papers prior to the convention, to promote active discussion on the convention floor. Editorially suitable papers also be printed in American Found-may also be printed in American Foundryman.

The forthcoming convention, 51st annual meeting of A. F. A., will be held in Detroit, April 28, through May 1. Occurring in a non-exhibit year, it will feature technical sessions, shop operations courses and the popular informal round-table luncheons.

Papers for the meeting may be submitted to the Technical Director, American Foundrymen's Association, 222 West Adams Street, Chicago 6, Ill.

Apprentice Winners' Prize Awards Increased

Cash awards for winners in the annual A.F.A. National Apprentice Contest will be substantially larger in 1947, as a result of action by the National Board of Directors at its Annual Meeting in July. First prize was increased from $25.00 to $100.00; second prize, from $15.00 to $50.00, and third prize, from $10.00 to $25.00, in each of the four contest divisions: gray iron molding, steel molding, non-ferrous molding and patternmaking.

The annual competition, sponsored by the A.F.A. Apprentice Contest Committee, opens in January of each year, and ends with announcement of winners at the Annual Convention. Apprentices may enter any or all divisions of the contest. Complete details may be obtained from the National Office.

Cupola Committee Will Continue Vital Program

Research indicated as necessary in earlier studies, will be undertaken by the Cupola Research Committee, which, under chairmanship of R. G. McElwee, Vanadium Corp. of America, Detroit, now enters the third phase of the work that has resulted in preparation of a bibliography on cupola operations and publication of the Handbook of Cupola Operation.

According to recent announcement of committee personnel, A. E. Schuh, U. S. Pipe & Foundry Co., Burlington, N. J., will serve as Vice-Chairman of the group for the coming year; and E. H. Stilwill, Crysler Corp., Dodge Div., Detroit, as Secretary.

Other members of the committee are: A. L. Boegehold, General Motors Research Labs., Detroit; Hyman Bornstein, Deere & Co., Moline, Ill., and E. C. Jeter, Ford Motor Co., Dearborn, Mich.

SKILL AND LEADERSHIP THROUGH APPRENTICE TRAINING

An apprenticeship system, to be successful, must be considered by management as an essential part of the business. If apprentice training is included in company activities, it must be given due importance if it is to produce satisfactory results.

J. E. Goss
Brown & Sharpe Mfg. Co.
Providence, R. I.

A MEETING of foundry owners and managers was held in a large Eastern city for the purpose of discussing apprenticeship training problems. During the discussion one man asked—"How many of us are prepared for the day when younger men must take our places"? Not one man at that meeting could say that he was ready for such a time.

The question referred to young men with good training and journeyman experience in foundry practice, plus good training and experience in foundry management. It has been proved that the best way to prepare foundry management personnel is by means of apprenticeship. The men at that meeting seemingly had not done a good job in this respect; in fact, several of them so admitted.

Purpose of Apprenticeship

Primarily, of course, apprenticeship is set up to train young men in molding and coremaking. Any other main objective would remove such training from the apprenticeship category. We shall continue to need more than management personnel. Try as we may to specialize our processes, there still will remain many foundry jobs calling for a variety of skills and a general knowledge of foundry casting practice.

If we subordinate the training for the work of journeymen to the training for management duties, the result will be that we shall produce neither good journeymen nor good managers. A practical training background is a definite asset to management. Also, management can function to better advantage if it has producers with the same kind of background.

If we agree with such a concept of foundry apprenticeship, we will predicate our plans upon a system which should give us both journeymen and management personnel. The required ratio of one to the other can be estimated roughly, and our system can be set up to come close to meeting these requirements.

Public Relations

Item number one in a foundry apprenticeship system should be a form of public relations. The definition commonly given to public relations will be recalled. It is the accomplishment of something good, followed by giving information about it to all who may be directly or indirectly interested.

Our first concern, then, is to place ourselves, if we are not already there, in a position where we can conscientiously tell about the foundry as a good place in which to work. This will not be easy. The mere word "foundry" seems, to many people, to be synonymous with dirt and danger, heat and heavy lifting.

Our public comprises parents of high school boys, school teachers, vocational advisors, parent-teacher groups, and the boys themselves. In planning to acquaint these people with opportunities in the foundry, we should bear in mind what seems to be an almost universal practice. It is the steering of the more intelligent boys toward college. The value of a college education need not be discounted in pointing out the opportunities for such boys in the foundry industry.

Source of Supply

What we are leading toward, in this so-called public relations work, is an adequate and satisfactory source of supply. By this time, probably, we all have recognized that concern about source of supply and careful testing of raw material should not be confined to pig iron, sands, binders, facings, and other such items.

The high schools and trade schools offer the most fertile fields, but in many high schools will be found the tendency on the part of principals and advisors to work toward a college education for the boys with good scholastic records.

Acquainting the key people in the secondary schools with possibilities in the foundry, particularly for such boys, may be done by talks to groups, at the schools, and by literature describing the training facilities and pointing out the kinds of work to which such training may lead.

To be effective, this publicity must not paint a rosy picture or present claims instead of facts. The new apprentice, if he is the type of boy we want, will be quick to compare what he has been told with the actualities he finds in the foundry. A large number of beginners and a large turnover will mean waste and, perhaps, discouragement over an ap-

Presented at an Apprentice Training Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 9, 1946.

prenticeship system. It is much better to attract fewer boys and to have them carry on their training.

When we test our incoming raw materials we do so with their definite uses in mind. When we test our raw apprenticeship material we are not usually testing competently selected material, as is generally the case with our irons and sands, nor can we know exactly to what uses this material eventually may be assigned. We can, however, come somewhere near the mark in determining our needs for both journeymen and supervisors during the next few years. Also, we can be mindful of what our management requirements may be some years thereafter.

Pre-employment tests for apprenticeship should be a distinct help to the foundryman, provided that he chooses the tests carefully, administers them properly, and then continues to use his judgment of people as an important factor in the hiring process.

System Planning

Selling foundry apprenticeship to individuals and groups requires the planning and carrying out of a system which can be explained in detail and with justifiable pride. We would not start our sons in a school or college on the mere assurance that they would be given an education. We would want to know what courses were offered and something about the content of each. We would inquire into extra-curricula activities, library facilities, and other means by which a predetermined objective could be attained.

A carefully thought out foundry program for apprentices is an advantage to all concerned. We want to produce journeymen molders with all-around training and experience; therefore, we must see to it that our apprentices are given, in an orderly, systematic way, what we believe to be the proper proportionate period of time on each phase of the molder's job.

Perhaps the best way to accomplish this is by centralization of apprentice training. The foundry superintendent and his foremen are interested principally in the production of castings. Any such duty as moving apprentices from one kind of work to another would be secondary and, therefore, sometimes neglected. But, foundry superintendents and foremen should never be left out of an apprenticeship system. It is important that they be a part of it, although it should not be expected that they will set aside their urgent production problems in favor of apprenticeship routine.

Apprenticeship Department

Centralization of apprenticeship training should mean better job instruction and better selection and presentation of class work. Moreover, it can be of assistance in the hiring of apprentices, if such hiring is done by a personnel department. It definitely can help in the placement of graduate apprentices and in the selection of foremen.

If the size of a foundry does not warrant the setting up of an apprenticeship department, much can be done by the appointment of a competent individual whose time may be devoted entirely to apprentice training. If the number of apprentices is too small to warrant the full time of a man, an arrangement might be made to assign a man, competent to supervise apprentices, to a job from which he can take whatever time is necessary for his training duties.

The importance of having the right man as a supervisor of apprentices can not be too greatly stressed. He should have much more than a thorough knowledge of the way in which good castings are produced. He must be able to impart that knowledge in readily understood terms and analyze jobs so that they can be taught in the order of their learning difficulties. He must decide on the variety of work that will give his apprentices the best experience and have the good will of the foreman so that such variety will be made available to the boys.

Supervisory Qualities

In addition to his techniques and their application to his work, he must be patient, forgiving to a reasonable degree, interested in youth and possess an understanding of people sufficient not only to enable him to grade apprentices but also to sense their potentialities.

Probably no one program of foundry assignments would fit any two apprenticeship systems, yet in determining our assignments and the length of time to be spent on each, we should bear in mind that our apprentices are to be taught a trade. They rightly should expect that an apprenticeship in one foundry will qualify them to readily adapt themselves to the work in another foundry producing castings of the same general classification.

Whether an apprentice is taught machine molding before he is taught bench molding may not be essential, but is is essential that he learn both molding methods during his apprenticeship time, since they are methods of making castings and, therefore, are parts of the molding trade.

Some foundrymen may hesitate to take apprentices because their regular facilities would not permit full training. If there are two or more foundries in a locality, an arrangement might be made whereby training which could not be given in one place would be available in another. Such a plan has proved to be quite practicable in at least one locality, in the machinist trade.

Supplemental Training

If an exchange arrangement is not possible or feasible, there is another way to give the apprentice a comprehensive program. This may be done by setting up, somewhere away from the manufacturing departments, whatever equipment is needed to make the training complete. Short, intensive instruction could be given and, although the values that we attach to a reasonable amount of repetitive work would be lacking, we should be able to feel that we had made up, at least in part, for whatever training our regular production practices did not permit.

An arrangement such as this has been working successfully in a large factory for many years, where it was found that it was not practicable to give certain instructions connected with the machinist trade in the manufacturing departments.

If we are to carry on an apprenticeship system that will produce competent journeymen, we must go further than establishing work assignments. Each assignment, if it is to be thoroughly covered, should be analyzed. Only in this way can we be certain that nothing with learning value has been omitted. This does not mean anything more than a little careful thought, the printing or mimeographing of the items on a pocket-size card, and then the

checking of these items when the apprentice has received instruction and practice in what they represent.

Usually, in apprenticeship, there are wide differences of opinion as to what should be taught the boys aside from actual molding practices; also, as to how and where this instruction should be given. These questions, seemingly difficult to answer satisfactorily, no doubt constitute the reason why some foundrymen, especially those operating the smaller places, are reluctant to train apprentices.

The trend appears to be in the direction of letting the public school system assume the responsibility for this so-called related work, even to the point of deciding the subjects to be taught.

Related Work

It must be admitted that circumstances make a considerable difference as to whether the foundry itself or the public school is selected as the place of training, but it would seem that the selection of subjects should be made on the basis of needs in the molding trade rather than on the general educational level so often found in cooperative programs.

Over the past two or three decades there has been a trend toward liberalization of subject matter. It may be true that a journeyman molder is better off, generally, if he knows something about physics and chemistry, but might we not just as reasonably include many other subjects more or less remotely connected with the educational needs of the average man?

This may be the appropriate place to express a word of caution about getting too far away from the fundamental principles of apprenticeship. For one thing, we are quite apt to use the word loosely, applying it to various forms of foundry training not designed or expected to produce journeymen molders.

Short-Term Programs

Today, in our efforts to cooperate with the Veterans Administration and other service organizations, we may incline still further toward short-term programs and think of them as apprenticeships. Specialized courses have their place in the foundry, but they do not supplant apprenticeship.

Apprenticeship calls for an agreement between the employer, the apprentice, and his parent or legal guardian. Otherwise, the training is not really apprenticeship, nor does it present either to the employer or his apprentice the obligation which both rightly should assume.

Unless a written agreement is made a definite part of our apprenticeship system, we are not conforming to accepted apprenticeship standards. In addition to the legal aspect, there is a certain psychological effect. It probably could be shown that employers who use an agreement fare far better than do others in the matter of keeping their apprentices.

Every right thinking foundry worker should understand that management must choose for its supervisory personnel the best among available candidates, regardless of whether or not those chosen are graduate apprentices. If we do a good job of selecting and training our apprentices, it is likely that at least some of them eventually will become good leadership material.

It would be a distressing commentary on an apprenticeship system that showed no supervisors and foremen rising out of the ranks of its own graduates. A poor management job would be indicated, and it would grow increasingly difficult to interest prospective apprentices.

Management Interest

To make an apprenticeship system work, management must continue to see it as an essential part of the business. If management leaves apprentice training entirely to an individual or to an administrative group and shows no further interest, it will fail eventually.

If a survey were made of foundries in which apprenticeship has bogged down or been discontinued, it probably would be found that top management was largely at fault. Management itself can best decide, of course, whether the nature of the work done in its foundry warrants the training of apprentices, but if such training is included in company activities it must be given due importance if it is to produce satisfactory results.

Perhaps some foundry managements hesitate about starting an apprenticeship system because of their unfamiliarity with this kind of training. Men experienced in this work have heard others say that apprentice training presented such problems and obligations, particularly to the smaller foundry, that it had not been incorporated as a means of skilled worker supply.

If such is the feeling today of any foundry management, it is only necessary to write the A.F.A. National Office for advice as to how to start and carry on the apprentice form of training. The A.F.A. Committee on Apprentice Training is the second oldest committee in the Association. Although its members are widely separated, it transacts much business throughout the year by using the mails. Fifty years have served not to make it old and inactive, but rather to vitalize and have it become recognized as an agency alive to its opportunties.

Twenty years ago apprenticeship often was referred to as dead. Today we note among industrialists an awareness of the real value of apprenticeship, and it is such work as has been done by A.F.A. that has contributed largely toward this change.

Appointed to Castings Inspection Committee

H. C. Stone, Belle City Malleable Iron Co., Racine, Wis., has been appointed Chairman of the A.F.A. Inspection of Castings Committee.

Others named to the group are: F. L. Bender, Chicago Hardware Foundry Co., North Chicago, Ill., Vice-Chairman; H. R. Youngkrantz, Apex Smelting Co., Chicago, Secretary; E. G. Leverenz, American Steel Foundries, East Chicago, Ind., Consultant; G. E. Dewald, Ampco Metal, Inc., Milwaukee; W. H. Gunselman, Samuel Greenfield Co., Inc., Buffalo, N. Y.; F. J. Poettgen, American Steel Foundries, East Chicago, and R. H. Terry, Detroit Diesel Engine Div., General Motors Corp., Detroit.

New Research Home

Stressing continuation of a research program now in its 27th year, A. J. Offner, president, American Society of Heating and Ventilating Engineers, New York, recently announced removal of the Society's Research Laboratory to Cleveland

NEW LITERATURE

Three new industrial photographic papers, extra light weight and possessing a high degree of translucence, have been announced by Eastman Kodak Co., Rochester 4, N. Y. Designed to speed the production of paper positives from engineering drawings and enable extra-high quality blueprints to be made, the papers, known as Reflex Copy TXA, Linagraph Ortho TXA and Linagraph Blue Sensitive TXA, possess high wet and dry strength and are suitable for filing or binding.

Industrial gas masks for protection against industrial gases of many types are described in a new 4-page bulletin, issued by Mine Safety Appliance Co., Braddock, Thomas and Meade Sts., Pittsburgh 8, Pa. Features described include fogproof construction, "All-Vision" facepiece, gas-tight fit without pressure points and speaking diaphragm, designed to insure perfect communication between men, over telephone and through speaking tubes.

Rapid, simple forming of metal stock, to close tolerances, is described in a 40-page, stiff-covered booklet, "The Dia-Acro System of Die-Less Duplicating," issued by O'Neil-Irwin Mfg. Co., Minneapolis 15. Thoroughly illustrated, the booklet describes and shows the company's benders, brakes and shears; presents specifications for each unit, and discusses and pictures applications and products.

Foundry applications in non-ferrous, gray iron, malleable and steel comprise one section of the 40-page booklet on "Refractory Specialties" issued by Ramtite Co., a division of S. Obermayer Co., 2563 W. 18th St., Chicago 8. Other sections concern: product description, including general instructions for using; boiler furnace applications and constructions; industrial furnace applications and constructions; and an appendix containing a glossary of terms, temperature and conversion tables and data regarding pyrometric cone temperatures, properties of gases, etc.

New, internally-loaded "Interno" bucker elevator for gentle handling of delicate, relatively small manufactured parts, is described in Folder No. 1983, issued by the manufacturer, Link-Belt Co., 307 N. Michigan Ave., Chicago 1.

Refractory products, and methods of their application in the foundry, are presented in the 40-page, ring bound catalog No. 46, issued by Chicago Retort & Fire Brick Co., 208 S. La Salle St., Chicago 4. The well illustrated stiff-bound booklet incorporates full details concerning products of the company, and describes such operations as lining ladles and patching cupolas.

Blast cleaning supplies available from Alloy Metal Abrasive Co., 311 Huron St., Ann Arbor, Mich., are described in a series of bulletins issued by that firm: No. 100, which also incorporates suggestions for specific cleaning problems; No. 110, concerned with "Alloy 99" shot; and No. 115, describing "Superblast," a mixture of grit and shot. Quality control, specifications and applications are considered.

Bulletin No. 28A, issued by Fisher Furnace Co., 5535 N. Wolcott Ave., Chicago 40, describes the "Monarch Simplex" melting and refining furnace. Specifications are given for the five models in the line of oil or gas fired units, and operation details are outlined.

Two new products are described in bulletins issued by Delta Oil Products Co., Milwaukee 9; "Bondite" organic binder, and "Permi-Bond" sea coal replacement. Characteristics, advantages and methods of application are presented in detail.

Conveniently indexed data on selection of welding electrodes is presented in the "Selectrode Chart," issued by Hollup Corp., 4700 W. 19th St., Chicago, division of National Cylinder Gas Co., Chicago. Applications, current requirements, physical characteristics, etc., are given regarding electrodes for welding cast irons, non-ferrous, and mild, low alloy and stainless steels.

Two new bulletins issued by Apex Smelting Co., 2537 W. Taylor St., Chicago 12, concern "Apex 50" aluminum alloy and "Apex Aluminum Flux." Quality control, chemical composition, typical mechanical properties and physical properties of the alloy are presented; and effect of flux on properties is considered.

Interesting illustrations of the use of roller conveyor lines in foundries, mills, machine shops and manufacturing plants are contained in a 16-page booklet, "Achieve Maximum Efficiency in High Speed Production with Standard Conveyors," issued by Standard Conveyor Co., North St. Paul 9, Minn.

Information regarding precision castings (specifications, design, manufacture, applications and advantages) is presented in a 20-page, stiff-covered booklet available from Haynes Stellite Co., unit of Union Carbide & Carbon Corp., Kokomo, Ind.

Basic principles of "Hydrocast" die casting are discussed in detail and diagrammed in three typical stages in Folder L-24-HB, issued by Hydropress, Inc., 570 Lexington Ave., New York 22. Features of the "Hydrocast" line of cold chamber die casting machines are shown and discussed, and specifications are given for Models 1 through 6.

Portable pyrometer, designed for rugged serviceability and to meet special requirements of the armed services, is described in Catalog 4350, released by Roller-Smith Div., Realty and Industrial Corp., Bethlehem, Pa. General details of construction and operation are given.

FOUNDRY PERSONALITIES

H. W. Holt, vice-president in charge of sales, Wilson Foundry & Machine Co., Pontiac, Mich., since joining the organization in 1941, assumes additional duties and responsibilities as vice-president and assistant general manager of the firm, **W. O. Leonard,** company president, has announced. Connected with the foundry industry

H. W. Holt

for 35 years, Mr. Holt served as production and sales manager, Aluminum Castings Co., Cleveland, and as vice-president and sales manager, Bohn Aluminum & Brass Corp., Detroit, prior to joining the Wilson firm.

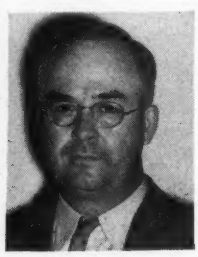
H. L. Strube, since 1941 chief engineer, Link-Belt Co., Philadelphia, heads the new general engineering division, recently announced by Chicago headquarters of the firm. Offices of the new division will be located at Philadelphia. **H. F. Watson,** head of the engineering standards department at the Philadelphia plant since 1943, and **C. M. Young,** long identified with product development and design at that plant, become assistant chief engineers, general engineering division.

E. J. Burnell, vice-president in charge of sales, Link-Belt Co., Chicago, announces appointment of **C. C. Wiley** as district sales engineer in charge of the firm's new sales office in the Comer Building, 2100 Second Ave. N., Birmingham 3, Ala. Mr. Wiley has been with the Link-Belt organization since 1926, for the past 17 years in the Pittsburgh sales office. **L. R. Clark,** associated with the company since 1927 and in sales since 1929, has been placed in charge of a new sales office at 730 Temple Bar Building, Main & Court St., Cincinnati.

J. S. Szymanski, formerly chief chemist, Cochrane Laboratories, Milwaukee, recently joined Western Metal Co., Chicago, as Wisconsin sales representative. Mr. Szymanski is a graduate of Marquette University, Milwaukee, where he received a Bachelor of Science degree in chemistry and metallurgy.

C. H. Welch, since 1928 superintendent, advances to plant manager; and **J. E. Gickler,** assistant superintendent since 1942, to superintendent, The Alloy Cast Steel Co., Marion, Ohio, in promotions announced by **M. C. McNeil,** pres-

J. E. Gickler



C. H. Welch

ident of the company. In the new post, Mr. Welch succeeds **W. A. Dorsey,** who retired recently as vice-president and works manager.

E. B. Westall, engaged in metallurgical research at the Naval Research Laboratory, Anacostia, Md., during service with the Navy, joined Hanford Foundry Co., San Bernardino, Calif., recently after release from the U. S. Naval Reserve with the rank of Lieutenant. Before entering the service, Mr. Westall was with Warman Steel Casting Co., Huntington Park, Calif. He is an active member of A.F.A., with the Chesapeake chapter while at Anacostia, and, earlier, with the Southern California chapter in the Los Angeles area.

W. L. Bayer

W. L. Bayer, president and chairman of the board, Canadian Bronze Co. Ltd., Montreal, Que., was honored at a luncheon in the Mount Royal Hotel, Montreal, on the occasion of his birthday which, this year, coincided with the 50th anniversary of the granting of the firm's charter. The function was in observance of both. Supervisory officers and members of the firm's Quarter Century Club earlier in the day presented Mr. Bayer with a bronze bust of himself.

K. W. Mueller, recently plant manager, Standard Stoker plant, Erie, Pa., moves to Reading, Pa., in the same capacity over the Reading-Pratt & Cady, Reading Steel Casting and d'Este divisions, American Chain & Cable Co. Also a director, Read Machinery Co., York, Pa., Mr. Mueller is a graduate in mechanical engineering from Cornell University, Ithaca, N. Y., and holds a Master's degree from Stevens Institute of Technology, Hoboken, N. J.

R. J. Rice will be in charge of the Texas technical section, development and research division, International Nickel Co., Houston, Texas, which he has established since joining the firm following his release from the Navy, early this year, with the rank of Lieutenant-Commander. Mr. Rice, who served with the Materials Division of the Navy Department, was commis-

sioned in the Navy late in 1942, after having been called to Washington as senior industrial specialist,

R. J. Rice

manganese-chrome branch, War Production Board, in January of that year. Earlier, he had been associated, as foundry engineer and metallurgist, with Metal Goods Corp., Houston, where he was concerned with the use of nickel in iron and steel foundries and the applications of nickel containing alloys.

J. F. Aicher, E. A. Wilcox Co., San Francisco, and Secretary, Northern California A.F.A. chapter, was one of the speakers at the High Frequency Heating Conference in San Francisco, September 5-6, sponsored by a number of organizations including A.F.A., AIME, ASM, ASME, ASTE, AWS and SAE. Mr. Aicher presented a technical paper on *Melting of Metals with Induction Heating.*

Oscar Blohm, Hills-McCanna Co., Chicago, and **H. E. Ferguson,** Acme Aluminum Foundry Co., of the same city, are delegates of the Chicago A.F.A. chapter to the Chicago Technical Societies Council. Alternate representatives are **L. H. Rudesill,** Griffin Wheel Co., and **J. T. Leisk,** Chicago Hardware Foundry Co., both of Chicago.

K. **H. Barnes** has been appointed chief engineer, **C. R. Cline** has been named engineering assistant to the president, and **S. S. Deputy** has been appointed assistant sales manager, by American Foundry Equipment Co., Mishawaka, Ind. Mr. Barnes, associated with the firm for the past 10 years, held the position of assistant sales manager until his present appointment. Recently separated from U. S. Army Ordnance Industrial Service with the rank of major, Mr. Cline has had an extensive and varied business background; and Mr. Deputy comes to the firm after an 18-year association in sales and administration capacities with International Business Machines, Inc.

H. H. Fairfield, until recently metallurgical engineer, metallurgical research laboratories, Bureau of Mines, Ottawa, Can., joins the staff of Harry W. Dietert Co., Detroit, as foundry consultant. Mr. Fairfield established the experimental foundry at the Bureau of Mines (which aroused the interest and admiration of delegates to the recent Ottawa Foundry Confer-

H. H. Fairfield

ence, reported in AMERICAN FOUNDRYMAN, June, 1946) after a survey of Canadian foundries; and carried out research and consulting work there for Canadian manufacturers, his main interest being directed to quality control in metallurgical processes. Mr. Fairfield is co-author, with A. E. Murton and Henri Louette, of *Core Sand, Purchasing Factors,* in this issue.

Raymond Depoux, general manager, and **Joseph Cantenot,** manager, both of Societe Metallurgique d'Aubrives-Villerupt, Villerupt (Moselle), France, and **Georges Bouchot,** manager, Establissements E. Schneider, Le Creusot, France, were recent distinguished visitors to the A.F.A. National Office. Accompanying them was **Auguste Bohler,** Amerlux Steel Products Corp., New York, who represents the companies in the United States. The d'Aubrives organization is one of the largest gray iron producers in France, and the Schneider steel and iron works has been well known to this country since World War I. Both Mr. Depoux and Mr. Bouchot extended American foundrymen a cordial invitation, through A.F.A., to inspect their plants when visiting Europe.

C. McA. Evans, released from the Navy with the rank of Captain, following more than five years service, was elected president of Chicago Steel Foundry Co., Chicago, at a recent meeting of the board of directors.

L. C. Gleason, assistant treasurer, Gleason Works, Inc., Rochester, N. Y., has assumed the duties of foundry superintendent.

S. H. Hammond, president, Whiting Corp., Harvey, Ill., has been named a director, Foundry Equipment Manufacturers Association, Cleveland.

J. N. Peters, associated for more than 20 years with the carbide and cast alloy industry, has been named manager carbide and cast alloy division, Jessop Steel Co., Washington, Pa.; and will supervise production and sales of tools, dies and wear resistant parts made from sintered and hot-pressed carbides and cast non-ferrous alloys.

T. A. Cohen, formerly vice-president, Wheelco Instruments Co., Chicago, is president; and **R. K.**

T. A. Cohen

West, on active duty with the Engineering Division, Navy Bureau of Aeronautics, Washington, D. C., during the war, is secretary-treasurer, of the new Taco West Corp., Chicago.

J. M. Planten, assistant foundry superintendent and foundry engineer, Sperry Gyroscope Co., New

(*Continued on Page 106*)

★ NEW A. F. A. MEMBERS ★

(Covering the period from August 15 to September 15)

● Four conversions head this month's list of 163 new memberships in A.F.A., as twenty-seven chapters report their growth. Chicago, with 17 new foundrymen, led all chapters but was pushed by Southern California which netted 16. Eastern Canada and Newfoundland, contributing 13 applications, took third highest honors.

Conversions—Company to Sustaining.

**Eaton Mfg. Co., Detroit. (E. C. Hoenicke, Gen. Mgr.)
**Singer Mfg. Co., Elizabeth, N. J. (Daniel Woolley)

Conversions—Personal to Company.

*Bennett Ireland Co., Norwich, N. Y. (John P. Irwin, Gen. Supt.)
*Tonawanda Iron Corp., No. Tonawanda, N. Y. (Leo A. Merryman, Mgr. of Sales)

BIRMINGHAM DISTRICT CHAPTER

W. Harry Bailey, Asst. Mgr., Alabama By-Products Corp., Birmingham.
Homer C. Carder, Works Mgr., Alabama By-Products Corp., Tarrant.
J. Frank Curry, Sales Repr., Alabama By-Products Corp., Birmingham.
Earl J. Fenton, Co-Owner, Fenton & Hagan Foundry, Ridgeland, Miss.
Roy Gaskin, Chemist, Alabama By-Products Corp., Tarrant.
W. D. Moore, Birmingham.
Roy H. Norris, Jr., Mgr., Coal Sales, Alabama By-Products Corp., Birmingham.
Henry E. Sykes, Fdry. Fore., Alabama Foundry Co., Birmingham.
J. M. Walton, American Brake Shoe Co., Birmingham.
Jack Williams, Sales Repr., Alabama By-Products Corp., Birmingham.

CANTON DISTRICT CHAPTER

A. T. Cafe, Vice Pres., Coast Metals, Inc., Canton.

CENTRAL INDIANA CHAPTER

A. Willard Anderson, Asst. Fdry. Supt., International Harvester Co., Indianapolis.
Walter Presecan, Group Leader Coreroom, International Harvester Co., Indianapolis.

CENTRAL NEW YORK CHAPTER

Eldon T. Barber, New York Air Brake Co., Watertown.
Morgan T. Fisher, V. P., Utica Steam Engine & Boiler Works, Utica.
Robert C. Markell, Fore., Straight Line Foundry & Machine Corp., Syracuse.
Joseph Otvos, Fore., Straight Line Foundry & Machine Corp., Syracuse.
John W. White, Core Room Fore., Straight Line Foundry & Machine Corp., Syracuse.

CENTRAL OHIO CHAPTER

Carl Mook, Asst. Patt. Fore., Cooper-Bessemer Corp., Mount Vernon.
Carl E. Pauly, Fdry. Supt., National Supply Co, Springfield.
Frank Scardina, Gen. Fore., National Supply Co., Springfield.

CHESAPEAKE CHAPTER

James H. Hinton, Jr., Molder, Norfolk Naval Shipyard, Portsmouth, Va.

CHICAGO CHAPTER

P. H. Bohlen, American Brake Shoe Co., Chicago Heights, Ill.
James F. Bork, Jr., Engr., Lester B. Knight & Associates, Inc., Chicago.
Chas. E. Coulter, Chicago Repr., Werner G. Smith Co., Chicago.
Arthur C. Eckborg, Mgr., Western District, National Crucible Co., Philadelphia.
E. N. Hauser, Chief Draftsman, National Engineering Co., Chicago.
C. R. Hilliker, American Brake Shoe Co., Chicago Heights, Ill.
Wilber O. Igelman, Met., National Malleable & Steel Castings Co., Cicero, Ill.
C. A. Maish, Engr., Lester B. Knight & Associates, Inc., Chicago.
Walter Nagell, Mgr., Prod. Engr. Dept., Whiting Corp., Harvey, Ill.
Anthus D. Oldham, Whiting Corp., Harvey, Ill.
C. J. Reynolds, Personnel Mgr., Sivyer Steel Castings Co., Chicago.
Clyde A. Sanders, Engr., American Colloid Co., Chicago.
D. Sheehy, American Brake Shoe Co., Chicago Heights, Ill.
J. Srebolus, American Brake Shoe Co., Chicago Heights, Ill.
P. H. Valkenburg, Supv. Eng., Whiting Corp., Harvey, Ill.
*Wells Mfg. Co., Des Plaines, Ill. (M. K. Wells, Pres.)
W. Woislaw, American Brake Shoe Co., Chicago Heights, Ill.

CINCINNATI DISTRICT CHAPTER

William M. Ball III, Cincinnati Milling Machine Co., Cincinnati.
Richard Earl Hughes, Student (Co-op), Wm. Powell Valve Co., Cincinnati.
*Xenia Foundry & Machine Co., Xenia, Ohio (W. M. Huston, Pres.)

DETROIT CHAPTER

John A. Bassett, Office Mgr., National Foundry Sand Co., Detroit.
Cecil R. French, Chemist, Packard Motor Car Co., Detroit.
Ray P. Powers, Asst. Chief Instr., Pontiac Div., Pontiac.
F. James Walls, Met., Dostal Per-Mold Co., Pontiac.

EASTERN CANADA & NEWFOUNDLAND CHAPTER

Lucien Berthiaume, Yard Fore., Warden King Ltd., Montreal, Que.
P. Blais, Appr. Molder, Montreal Technical School, Montreal, Que.
C. Corriveau, Appr. Molder, Montreal Technical School, Montreal, Que.
R. E. Delaney, Mgr., H. Walford Ltd., Montreal, Que.
*Forano, Plessisville, Que. (J. A. Forand, Pres.)
*Hardware & Woodenware Inc., Coaticook, Que. (J. E. R. Roberge, V. P.)
Earl Jones, Appr. Molder, Montreal Technical School, Montreal, Que.
L. Limoges, Appr. Molder, Montreal Technical School, Montreal, Que.
Marc Melanson, Pres., Melanson Foundry, Montreal, Que.
James E. Quig, Pres., Warp Tension Governors Ltd., Cornwall, Ont.
J. J. Rondeau, Student, Ecole Polytechnique, Montreal, Que.
Robert Seale, Partner, Dominion Brass & Aluminum Foundry Co., Pierre, Que.
Frank Yaworsky, Cost Control Clerk, Canadian Car & Foundry Co. Ltd., Montreal, Que.

METROPOLITAN CHAPTER

*Bierman-Everett Foundry Co., Irvington, N. J. (M. J. Hogan, Secy.)
Edward F. Dieterle, Mgr., James Spence Iron Foundry, Inc., Jersey City, N. J.
W. H. Ferguson, Electro Metallurgical Sales Corp., New York.
V. Julius, Treas., Bierman-Everett Foundry Co., Irvington, N. J.
Clinton H. Moore, Serv. Engr., Swan Finch Oil Corp., New York.
A. E. Rising, Jr., Res. Met., Reynolds Research, Glen Cove, L. I., N. Y.
*James Spence Iron Foundry, Inc., Jersey City, N. J. (Alexander J. Spence, Pres.)

MICHIANA CHAPTER

Harvey C. Chaden, Supt., South Bend Smelting & Refining Co., South Bend, Ind.
H. M. Miller, V. P. & Treas., American Foundry Equipment Co., Mishawaka, Ind.
Walter Ostrowski, Fore., American Foundry Equipment Co., Mishawaka.
Harold F. Schulte, Sales Engr., American Foundry Equipment Co., Mishawaka, Ind.
J. E. Skene, Sales Engr., American Foundry Equipment Co., Mishawaka

NORTHERN CALIFORNIA CHAPTER

E. C. Friday, Sales, National Carbon Co., Inc., San Francisco.
Robert B. Grover, Molder, Palmquist Foundry, Oakland.
Ing. Juan B. Vazquez, Gral. Supt., Hornos y Talleres, S. de R. L. Guadalupe, Montenegro No. 176, Mexico.

NORTHEASTERN OHIO CHAPTER

Robert G. George, Fdry. Supt., Eberhard Mfg. Co., Cleveland.
D. R. Grandy, Mfgr's. Representative, Cleveland.
Howard E. Heyl, Salesman, Federal Foundry Supply Co., Cleveland.

*Company Members.
**Sustaining Members.

NO. ILLINOIS-SO. WISCONSIN CHAPTER

Wayne M. Breisch, Met., Rockford Clutch Div., Borg Warner Corp., Rockford, Ill.

Richard A. Oster, Trade & Ind'l. Coordinator, Beloit School of Vocational & Adult Education, Beloit, Wis.

John S. Zabel, Chemist & Spectroscopist, Fairbanks Morse & Co., Beloit, Wis.

NORTHWESTERN PENNSYLVANIA CHAPTER

David W. Dale, Patt. Fore., Griswold Mfg. Co., Erie.

George Johnstone, Jr., President, Lawrence Foundry Co., Grove City.

B. H. Scott, Gen. Sls. Mgr., Erie Malleable Iron Co., Erie.

*Tanner Mfg. Co., Erie. (Theo. L. Bauer, Gen. Mgr.)

OREGON CHAPTER

W. M. Armstrong, Assoc. Prof., Dept. Mining & Metallurgy, University of British Columbia, Vancouver, B. C.

Geo. E. Battin, Owner, Northwest Pattern Works, Portland.

M. N. Sigovich, Salesman, National Carbon Co., Inc., New York.

PHILADELPHIA CHAPTER

W. J. Campbell, American Brake Shoe Co., New Castle, Del.

William W. Dinkel, Prod. Engr., D. A. Dinkel & Son, Hamburg, Pa.

Fred J. Liederbach, Jr., Mechanical Engr. Apprentice, Western Foundry Co., Chicago.

P. McCulloch, American Brake Shoe Co., New Castle, Del.

William N. Rice, Chief Insp., Bethlehem Steel Co., Bethlehem, Pa.

W. L. Vaughan, American Brake Shoe Co., New Castle, Del.

W. P. White, American Brake Shoe Co., New Castle, Del.

F. G. Yacucci, American Brake Shoe Co., New Castle, Del.

QUAD-CITY CHAPTER

Ted L. Burkland, Met., John Deere Harvester Works, East Moline, Ill.

*Ferro Bronze Corp., Moline, Ill. (Mark A. Ashmore, Gen. Mgr.)

George T. French, Asst. Supt., Union Malleable Iron Works, East Moline, Ill.

Boyd L. Hays, Gen. Fore., Union Malleable Iron Works, East Moline, Ill.

Jack A. Shipley, Gen. Foreman of Foundry, John Deere Spreader Works, East Moline, Ill.

ROCHESTER CHAPTER

C. V. Maurice, American Brake Shoe Co., Rochester, N. Y.

SAGINAW VALLEY CHAPTER

Alfred M. Downum, Co-op. Student, General Motors Institute, Flint, Mich.

Alberto Schiesser, Student, General Motors Institute, Flint, Mich.

ST. LOUIS DISTRICT CHAPTER

*The Acme Foundry & Machine Co., Coffeyville, Kansas. (G. H. Graham, Sec'y.)

A. F. Chapie, American Brake Shoe Co., St. Louis.

J. S. Demos, American Brake Shoe Co., St. Louis.

Harvey Fall, Fore., Bastian Morley Co., Harrisonville, Mo.

Q. W. Gotsch, American Brake Shoe Co., St. Louis.

E. L. Hude, American Brake Shoe Co., St. Louis.

G. F. Kaufman, American Brake Shoe Co., St. Louis.

SOUTHERN CALIFORNIA CHAPTER

E. A. Aasen, Owner, Whittier Pattern Works, Whittier.

James Brady, Supt., Overton Foundry, Southgate.

Victor Caliva, Owner, Aircraft Foundry Co., Huntington Park.

Philip H. Clapp, Dist. Mgr., Norton Co., Los Angeles.

W. A. Dewhurst, Brumley-Donaldson Co., Huntington Park.

G. Glittenberg, American Brake Shoe Co., Los Angeles.

Henry J. Lindow, Partner, Precision Aluminum & Brass, Gabriel.

*H. C. Little Burner Co., Inc., San Rafael. (L. L. Little, Treas.)

Charles T. Ludwig, Supt., Commercial Enameling Co., Los Angeles.

Norman S. Martin, H. E. McGowan Co., Los Angeles.

S. Marurn, American Brake Shoe Co., Los Angeles.

James E. McGraw, Supt., I. H. Rober Co., Huntington Park.

S. W. Petresky, Fore., Arizona Iron Works, Phoenix, Ariz.

H. M. Rutledge, Sales Engr., National Carbon Co., Los Angeles.

W. H. Stanfield, Owner, Whittier Pattern Works, Whittier.

Alvin N. Whitson, Asst. Met., Clarke Steel Co., Inc., Los Angeles.

TEXAS CHAPTER

Frank Streun, Partner, Bonham Foundry Co., Bonham.

Kenneth W. Dickey, Partner, Bonham Foundry Co., Bonham.

Frank A. Fournier, Patternmaker, F & J Pattern Works, San Antonio.

J. H. Kimes, Jr., Met., Lufkin Foundry & Machine Co., Lufkin.

Dick Matheny, Core Room Fore., East Texas Electric Steel Co., Longview.

Chas. Sibbitt, Owner, Refinery Castings Co., Dallas.

Frank Streun, Partner, Bonham Foundry Co., Bonham.

*Tips Engine Works, Austin. (Ralph C. Goeth, Pres.)

WESTERN MICHIGAN CHAPTER

*John Bean Mfg. Co., Lansing. (Art David, Plant Supt.)

Frank A. Mason, Advisor Consultant, Foundry Service Engineers, Grand Rapids.

Lynn N. Pangborn, Sales Engr., National Foundry Sand Co., Detroit.

Howard L. Wolf, Asst. Met., John Bean Mfg. Co., Lansing.

WESTERN NEW YORK CHAPTER

Benton W. Aspell, Met., Acme Steel & Malleable Iron Works, Buffalo.

Frank P. Breier, Sales, Tonawanda Iron Corp., No. Tonawanda.

Neal E. Dunning, Supv. Studs. Dept., Acme Steel & Malleable Iron Works, Buffalo.

Edwin A. Hempel, Asst. Prod. Mgr., Acme Steel & Malleable Iron Works, Buffalo.

Charles R. Holzworth, Vice Pres., Tonawanda Iron Corp., No. Tonawanda.

WISCONSIN CHAPTER

Arthur J. Ehne, Pelton Steel Casting Co., Milwaukee.

Arthur R. Jones, Jr., Standard Foundry Co., Racine.

OUTSIDE OF CHAPTER

C. E. Acklin, American Manganese Steel Div., Denver, Colo.

W. T. Boish, American Brake Shoe Co., Pittsburgh.

J. V. Brunner, American Manganese Steel Div., Denver, Colo.

J. L. Grubesic, American Manganese Steel Div., Denver, Colo.

George J. Jackson, Supt., Walworth Co., Boston.

Wm. F. Kunz, Pttn. Fore., Oklahoma Steel Castings Co., Tulsa, Okla.

L. W. Lauer, American Brake Shoe Co, Pittsburgh.

R. L. Marsalli, American Manganese Steel Div., Denver, Colo.

H. W. Paul, American Manganese Steel Div., Denver, Colo.

Martin Steidfeldt, Walworth Co., South Boston.

Carl Townsend, Core Rm. Fore., Oklahoma Steel Castings Co., Tulsa.

Edward H. Williams, National Radiator Co., New Castle, Pa.

Czechoslovakia

Vladimir Zednik, Ing. Dr. High School of Mining & Metallurgical Engr. Rasinova 1 Mor. Ostrava.

England

Alar Ltd., 35 New Broad St., London EC 2.

The Librarian, H. M. Patent Office London, W. C. 2.

Holland

Philips Onderwijs & Volksontwikkeling, Fellenoord 28C, Eindhovan.

Scotland

*G. & J. Weir, Ltd., Halin Foundry, Cathcart, Glasgow. (John Arnott, Chief Chemist)

Sweden

Bergsengemor Torbern Bratt, Guldsmedshytte Aktiebolag, Guldsmedshyttan.

*Company Members.

CHAPTER OFFICERS

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Sacks-Barlow Foundries, Inc.
Newark, N. J.
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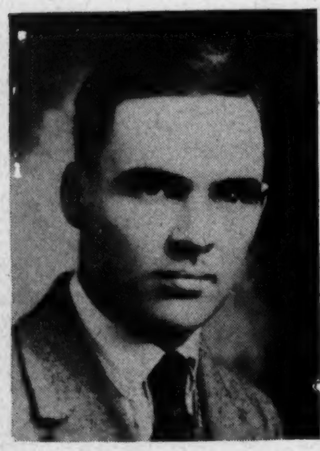
Birmingham District Chapter

E. M. Strick
Erie Malleable Iron Co.
Erie, Pa.
Chairman
Northwestern Pennsylvania Chapter

L. H. Denton
Baltimore Convention Bureau
Baltimore, Md.
Secy.-Treas.
Chesapeake Chapter



John Clausen
Greenlee Bros. & Co.
Rockford, Ill.
Vice Chairman
No. Illinois-So. Wisconsin Chapter

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Chevrolet Grey Iron Foundry Div.,
General Motors Corp.
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Chairman
Saginaw Valley Chapter

W. G. Brayer
Bausch & Lomb Optical Co.
Rochester, N. Y.
President
Rochester Chapter

W. R. Pindell
Northwest Foundry & Furnace Co.
Portland, Ore.
Chairman
Oregon Chapter

★ CHAPTER ACTIVITIES ★

news

Rochester

D. E. Webster
American Laundry Machinery Co.
Chairman, Publicity Committee

THE NEW SEASON was ushered in by Rochester A.F.A. chapter with its third annual Clam Bake, staged September 7 at the Point Pleasant Hotel on Irondequoit Bay.

An afternoon devoted to a program of sports and games preceded the bake, and attendance was close to 150. In addition to members and their friends, a number of out-of-town guests were on hand and the chapter was honored by the presence of city and county officials.

Southern California

R. R. Haley
Advance Aluminum & Brass Co.
Chairman, Publicity Committee

INDICATIONS that the coming season will be one of action and accomplishment for Southern California A.F.A. chapter were seen in the large turnout and the general enthusiasm at the annual Summer Stag, which took place August 10 at the Lakewood Country Club, Long Beach, Calif. Some 450 foundrymen were on hand for the affair, which started at noon and lasted through the evening.

Golf, horseshoes, races and baseball took up the afternoon for most, while others were occupied with singing and general relaxation. Luncheon was generally acclaimed as an outstanding triumph, but the climax to the occasion was the evening's entertainment arranged by Harold Pagenkopp, Angelus Pattern Works, Los Angeles, new entertainment chairman.

Philadelphia

FIRST POST-WAR Regional Foundry Conference sponsored by the Chesapeake, Metropolitan and Philadelphia A.F.A. chapters, will take place at Town Hall, Philadelphia, on Friday and Saturday, November 1-2, culminating a summer of intense activity for committees of the three groups engaged in arrangements. Mounting interest of foundrymen throughout the area is considered indicative of an unprecedentedly successful meeting, especially in view of favorable recollections of the last such area gathering, held at Rutgers University, New Brunswick, N. J., before the war.

Valuable Program

The present conference, occurring at a time when many important problems confront the foundry industry, presents a number of outstanding foundrymen, well qualified to discuss technical and practical aspects of the castings field before the steel, gray iron and malleable, and non-ferrous sections.

Among foundry leaders participating are: John Howe Hall, foundry consultant, Swarthmore, Pa., who will preside over the initial steel session, and T. E. Eagan, Cooper-Bessemer Corp., Grove City, Pa., and W. W. Levi, Lynchburg Foundry Co., Lynchburg, Va., who also will serve as session chairmen; while Dr. Blake M. Loring, Naval Research Laboratory, Washington, D. C.; W. G. Reichert, W. G. Reichert Engineering Co., Newark, N. J.; J. H. Lansing, Malleable Founders' Society, Cleveland; W.

Vista across the Lakewood Country Club, Long Beach, Calif., on August 10, during the summer party of Southern California A.F.A. chapter.

B. McFerrin, Electro Metallurgical Co., Detroit; R. E. Ward, Eclipse Pioneer Div., Bendix Aviation Corp., Teterboro, N. J., and H. C. Winte, Worthington Pump and Machinery Corp., Buffalo, N. Y., will present technical papers.

Complete program for the conference is listed in adjoining columns.

Chicago

RESUMPTION of a series of annual gatherings interrupted by wartime regulations, is awaited by foundrymen of the midwest, with the stage set for the Chicago Regional Foundry Conference at the Continental Hotel, Chicago, November 21-22. Final touches were put on a program rich in technical and practical papers on up-to-the-minute aspects of castings technology at a meeting of the arrangements committee, September 18, in the A.F.A. National Office.

Committee chairman A. W. Gregg, Whiting Corp., Harvey, Ill.,

(Concluded on Page 88)

Regional Foundry Conference
November 1-2
Town Hall, Philadelphia

Friday, November 1

8:30 am—Registration

10:00 am—General Session
CHAIRMAN, W. W. Maloney, Secretary-Treasurer, American Foundrymen's Association.
Recent Developments in the Foundry Industry, Frank Steinebach, *The Foundry,* Cleveland.

12 noon—Luncheon

1:00 pm—Steel Session
CHAIRMAN, John Howe Hall, Foundry Consultant, Swarthmore, Pa.
CO-CHAIRMAN, W. W. Swayze, Deemer Steel Casting Co., New Castle, Del.
Steel Castings for Naval Use, H. E. Cragin, Jr., Taylor Wharton Iron & Steel Co., Highbridge, N. J.

1:00 pm—Gray and Malleable Iron Session
CHAIRMAN, R. L. Salter, Southern Wheel Div., American Brake Shoe Co., New York.
Should Your Foundry be Fully Mechanized?, W. G. Reichert, W. G. Reichert Engineering Co., Newark, N. J.

1:00 pm—Non-Ferrous Metals Session
CHAIRMAN, C. L. Frear, Bureau of Ships, Washington, D. C.
Synthetic Sands for the Non-ferrous Foundry, S. W. Brinson, U. S. Naval Shipyard, Norfolk, Va.

2:30 pm—Steel Session
Sand Compounding for Large Castings, Douglas Taylor, Bethlehem Steel Co., Bethlehem, Pa.

2:30 pm—Gray and Malleable Iron Session
CHAIRMAN, H. L. Ullrich, Sacks-Barlow Foundries, Newark, N. J.
Pattern and Casting Design, J. H. Lansing, Malleable Founders' Society, Cleveland.

2:30 pm—Non-Ferrous Metals Session
CHAIRMAN, David Tamor, American Chain & Cable Co., York, Pa.
Pressure Tightness of Bronze Castings, Dr. Blake M. Loring, Naval Research Laboratory, Washington, D. C.

3:45 pm—Steel Session
Progress in Precision Casting, Philip DeHuff, Westinghouse Corp., Lester, Pa.

4:00 pm—Gray and Malleable Iron Session
CHAIRMAN, W. W. Levi, Lynchburg Foundry Co., Lynchburg, Va.
Modern Foundry Refractories, C. E. Bales, Ironton Fire Brick Co., Ironton, Ohio.

4:00 pm—Non-Ferrous Metals Session
CHAIRMAN, E. J. Bush, U. S. Naval Gun Factory, Washington, D. C.
Comparison of Foundry Characteristics of Various Aluminum Alloys, R. E. Ward, Eclipse Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.

8:00 pm—Dinner and Entertainment

Saturday, November 2

8:00 am—Registration

8:30 am—Steel Session
CHAIRMAN, A. L. Wentzel, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
CO-CHAIRMAN, J. A. Gillis, Bethlehem Steel Co., Steelton, Pa.
Why Doesn't the Blind Riser Function on High Alloy?, Carl Wheeler, Jr., American Steel Castings Co., Newark, N. J.

8:30 am—Gray and Malleable Iron Session
Molding Materials, C. B. Schureman, F. E. Schundler & Co., Joliet, Ill.

8:30 am—Non-Ferrous Metals Session
CHAIRMAN, J. E. Crown, U. S. Naval Gun Factory.
Melting and Furnace Problems in Brass and Bronze Foundries, H. L. Smith, Federated Metals Div., American Smelting & Refining Co., Pittsburgh, Pa.

9:30 am—Gray and Malleable Iron Session
CHAIRMAN, George Hadzima, Robins Conveyors, Inc., Passaic, N. J.
Gates and Risers for Sound Castings, H. C. Winte, Worthington Pump & Machinery Corp., Buffalo, N. Y.

10:00 am—Steel Session
Problems in the Production of Turbine Castings, J. A. Wettergreen, General Electric Corp., Schenectady, N. Y.

10:30 am—Gray and Malleable Iron Session
CHAIRMAN, T. E. Eagan, Cooper-Bessemer Corp., Grove City, Pa.
Casting Defects—Their Causes and Corrections, W. B. McFerrin, Electro Metallurgical Co., Detroit.

10:30 am—Non-Ferrous Metals Session
CHAIRMAN, C. A. Robeck, Gibson & Kirk Company, Baltimore, Md.
Melting Problems of Special Non-Ferrous Alloys, W. W. Edens, Ampco Metal, Inc., Milwaukee.

11:15 am—Steel Session
Stack Molding Using the Washburn Principle, J. A. Williams, Dodge Steel Co., Philadelphia.

Chicago Regional Foundry Conference
November 21-22
Continental Hotel, Chicago

Thursday, November 21

9:00 am—Registration

10:00 am—Opening Meeting
CHAIRMAN, L. H. Hahn, Sivyer Steel Castings Co., Chicago.
Address of Welcome, Dr. H. F. Moore, University of Illinois, Urbana.
Good Housekeeping and Plant Maintenance, James Thomson, Continental Foundry & Machine Co., East Chicago, Ind.

12 noon—Luncheon Meeting
CHAIRMAN, F. W. Shipley, Caterpillar Tractor Co., Peoria, Ill.
Speaker, Dr. H. T. Heald, Illinois Institute of Technology, Chicago.

2:00 pm—Gray Iron Session
CHAIRMAN, H. W. Johnson, Wells Mfg. Co., Des Plaines.
Cupola Refractories, R. A. Witschey, A. P. Green Fire Brick Co., Chicago.

2:00 pm—Non-Ferrous Session
CHAIRMAN, W. B. George, R. Lavin & Sons, Inc., Chicago.
Budgeting Foundry Costs, J. W. Wolfe, Non-Ferrous Founders' Society, Chicago.

2:00 pm—Malleable Session
CHAIRMAN, W. D. McMillan, International Harvester Co., Chicago.
Metallurgy of Malleable Iron, Dr. C. H. Lorig, Battelle Memorial Institute, Columbus, Ohio.

2:00 pm—Steel Session
CHAIRMAN, F. B. Skeates, Link-Belt Co., Chicago.
Non-Metallic Inclusions in Steel Castings, F. W. Boulger, Battelle Memorial Institute.

2:00 pm—Pattern Session
CHAIRMAN, James Gammie, American Steel Foundries, Hammond, Ind.
Co-operation Between the Foundry and the Pattern Shop, L. F. Tucker, City Pattern Works, South Bend.

3:40 pm—Gray Iron Session
CHAIRMAN, C. G. Mate, Greenlee Foundry Co., Chicago.
Cupola Control and Operation, T. E. Barlow, Battelle Memorial Institute.

3:40 pm—Non-Ferrous Session
CHAIRMAN, W. B. George, R. Lavin & Sons, Inc.
Melting Problems of Special Bronzes, Walter Edens, Ampco Metal, Inc., Milwaukee.

3:40 pm—Malleable Session
CHAIRMAN, B. C. Yearley, National Malleable & Steel Castings Co., Cleveland.
Malleable Gating and Feeding Practice, J. H. Lansing, Malleable Founders' Society, Cleveland.

3:40 pm—Steel Session
CHAIRMAN, E. L. LaGrelius, American Steel Foundries, East Chicago, Ind.
Welding of Steel Castings—Stress Relieving and Testing, J. K. McDowell, Rock Island Arsenal, Rock Island, Ill.

3:40 pm—Pattern Session
CHAIRMAN, Martin Rintz, Continental Foundry & Machine Co.
Pressure Plate and New Pattern Equipment, Melville E. Kohler, Scientific Cast Products Co., Cleveland.

6:00 pm—Conference Banquet
CHAIRMAN, A. W. Gregg, Whiting Corp., Harvey, Ill.
Speaker, Clifton Utley, news analyst and radio commentator, Chicago.

Friday, November 22

10:00 am—Gray Iron Session
CHAIRMEN, H. M. St. John, Crane Co., Chicago, and C. E. McClure, Crane Co., Chicago.
Sand Control, G. W. Anselman, Goebig Mineral Supply Co., Chicago.
Binders, A. C. Den Breejen, Hydro-Blast Corp., Chicago.

10:00 am—Non-Ferrous Session
CHAIRMAN, Oscar Blohm, Hills-McCanna Co., Chicago.
Gas Porosity in Aluminum Castings, Hiram Brown, Solar Aircraft Co., Des Moines, Iowa.

10:00 am—Malleable Session
CHAIRMAN, C. C. Lawson, Wagner Malleable Iron Co., Decatur, Ill.
Modern Malleable Melting and Annealing, W. R. Jaeschke and C. R. Taylor, Whiting Corp.

10:00 am—Steel Session
CHAIRMAN, R. E. Kerr, Pettibone-Mulliken Corp., Chicago.
Hardenability of Steel Castings, E. J. Wellauer, Falk Corp., Milwaukee.

10:00 am—Pattern Session
CHAIRMAN, H. K. Swanson, Swanson Pattern & Model Works, East Chicago, Ind.
Permanent Molds and Equipment, V. J. Sedlon, Master Pattern Co., Cleveland.

10:55 am—Non-Ferrous Session
CHAIRMAN, Oscar Blohm.
Sand Properties and Their Relation to Casting Defects, Fred Overstreet, Illinois Clay Products Co., Chicago.

12 noon—Luncheon Meeting
CHAIRMAN, L. H. Hahn, Sivyer Steel Castings Co., Chicago.
Speakers, Earl Shaner, president, Penton Publishing Co., Cleveland, and Dr. O. W. Eshbach, Northwestern University, Evanston, Ill.

2:00 pm—Core Blowing Session
CHAIRMAN, H. A. Forsberg, Continental Foundry & Machine Co.
Co-CHAIRMAN, Angelo Paoli, National Malleable & Steel Castings Co., Cicero, Ill.
Sands for Core Blowing, A. W. Magnuson, Champion Foundry & Machine Co., Chicago.
Pattern Equipment for Core Blowing, Zigmond Madacey, Caterpillar Tractor Co.
Core Blowing Equipment, L. D. Pridmore, International Molding Machine Co., Chicago.

Babcock & Wilcox Co., Canal Fulton, and C. J. Trump, Machined Steel Castings Co., Alliance.

Time out for refreshments at the Otis D. Clay Farm, near Canal Fulton, Ohio, during the Third Annual Picnic of Canton District A.F.A. chapter on August 17.

presided during the final check on speakers, chairmen and activities for the long-awaited event.

Co-sponsors with Chicago A.F.A. chapter of this first Chicago regional meeting since 1941 are Central Illinois A.F.A. chapter; Illinois Institute of Technology, Chicago; Northwestern University, Evanston, Ill., and University of Illinois, Urbana.

Although the conference itself terminates with the core-blowing session of Friday afternoon, November 22, visiting foundrymen will have an opportunity to see the model foundry at the Museum of Science and Industry, Jackson Park, Chicago, in operation on Saturday morning and the football game between Northwestern University and the University of Illinois Saturday afternoon.

As previously reported in AMERICAN FOUNDRYMAN, two special heats will be poured at the Museum for the benefit of conference visitors; and a block of tickets for the game has been secured, with attendance arrangements being handled by T. J. Magnuson, J. S. McCormick Co., Chicago.

Earl Shaner, president of Penton Publishing Co., Cleveland, and iron and steel consultant to the Pauley Reparations Commission, will address the luncheon meeting of Friday, November 22, on "Around the World in 40 Minutes."

Complete program for the conference is presented on Page 87.

Canton District

C. B. Williams
Massillon Steel Casting Co.
Chapter Secretary

A DAY OF FUN was notched into the calendar on August 17, as 150 members and guests gathered at the Otis Clay Farm, Canal Fulton, Ohio, for Canton District A.F.A. chapter's third annual picnic.

Despite overcast and rain, activities began in the early afternoon. Some of those present took to horseback, choosing their mounts from the farm's stable of riding horses; others indulged in sports and games between showers. Garage and basement were put to advantage during the rain. Following dinner, the day's festivities were topped off by movies and awarding of door prizes.

Arrangements for the occasion were handled by the entertainment committee under chairmanship of R. A. Epps, Stoller Chemical Co., Akron, Ohio. Fred Basler, A. P. Green Fire Brick Co., Canton, Ohio, is co-chairman of the committee and other members are: D. T. Born, American Steel Foundries, Alliance, Ohio; C. F. Bunting, Pitcairn Co., Barberton, Ohio; O. D. Clay, Tuscora Foundry Sand Co., Canal Fulton; Charles Scoville,

Northeastern Ohio

Edwin Bremer
The Foundry
Chapter Reporter

OPENING MEETING of the season for Northeastern Ohio A.F.A. chapter was held September 12 at the Cleveland Club, with more than 200 members and guests present to hear Dr. R. L. Lee, General Motors Corp., Detroit, discuss "Humanics in the Foundry."

The speaker stated that, while instruments and equipment are available for accurate measurements of many types, there is no way of gaging the human element, the most important factor in industry. However, there are a number of factors regarding human behavior which, when properly co-ordinated and applied, knit a group of heterogeneous individuals into a smoothly functioning organization.

The same kind of fact finding honesty, ingenuity and faith so successfully employed in solving mechanical problems, Dr. Lee said, will produce even greater results in terms of employee relations when applied to human behavior.

New England

M. A. Hosmer
Hunt-Spiller Mfg. Corp.
Association Reporter

ROUND TABLE DISCUSSION of "How to Make Gray Iron Castings with Less Pig Iron" was the technical program of the evening at the first fall meeting for the New England Foundrymen's Association, held September 11 at the Engineer's Club, Boston, and marked by record-breaking attendance.

Moderator and discussion leader for the session was D. L. Parker, General Electric Co., West Lynn, Mass.; and speakers were A.F.A. National Director H. H. Judson, Standard Foundry Co., Worcester, Mass., and Joseph Stazinski, General Electric Co.

Following presentations of the speakers, the meeting was thrown open to general discussion, and the foundrymen related their experiences with carbon raising materials.

CHAPTER MEETINGS

OCTOBER-NOVEMBER

October 21

Quad City

Hotel Fort Armstrong,
Rock Island, Ill.
August Christen
Arcade Manufacturing Co.

October 25

Texas

Golfcrest Country Club,
Houston
Round Table Discussion

Ontario

Royal York Hotel, Toronto
Quiz Night

Chesapeake

Engineers Club, Baltimore, Md.
J. Howard Ware
Redford Iron & Equipment Co.
Core Blowing and Core Sand Mixtures

October 28

Northwestern Pennsylvania

Moose Club, Erie
Harry W. Dietert
Harry W. Dietert Co.
Review of Molding Sand Problems

Central Ohio

Chittenden Hotel, Columbus
L. P. Robinson
Werner G. Smith Co.
Core Room Problems

November 1

Northern California

Engineers Club, San Francisco
L. C. Young
S.P.O., Inc.
Machine Molding in the Foundry

REGIONAL CONFERENCE
November 1-2
Philadelphia, Metropolitan and Chesapeake
Town Hall, Philadelphia

November 4

Metropolitan

Essex House, Newark, N. J.
E. C. Hoenicke
Eaton Mfg. Co.
Permanent Mold Castings

Central Indiana

Hotel Antlers, Indianapolis
R. A. Clark
Electro Metallurgical Co.
Principles of Cupola Operation

November 5

Saginaw Valley

Fischers Hotel, Frankenmuth, Mich.
E. E. Woodliff
Foundry Sand Service Engineering Co.
Molding and Core Sand Binders

November 8

Philadelphia

Engineers Club
Round Table Discussion

Wisconsin

Schroeder Hotel, Milwaukee

November 11

Cincinnati District

Engineering Society Headquarters,
Cincinnati
F. J. Wurscher
Semet-Solvay Co.
Caught Mapping

November 12

No. Illinois-So. Wisconsin

Faust Hotel, Rockford, Ill.
C. E. Westover
Westover Engineers
Cost Controls and Wage Incentives in the Foundry

November 14

Northeastern Ohio

Cleveland Club
Sectional Meeting

Canton District

Elks Club, Alliance, Ohio
Round Table Discussion

November 19

Twin City

Curtis Hotel, Minneapolis
N. J. Dunbeck
Eastern Clay Products, Inc.
Synthetic Sands

REGIONAL CONFERENCE
November 21-22
Chicago and Central Illinois
Continental Hotel, Chicago

ABSTRACTS

NOTE: The following references to articles dealing with the many phases of the foundry industry, have been prepared by the staff of *American Foundryman* from current technical and trade publications.

When copies of the complete articles are desired, photostat copies may be obtained from the Engineering Societies Library, 29 W. 39th St., New York, N. Y.

Analysis

SPECTROCHEMICAL. Saunderson, J. L., and Jess, L. M., *"Commercial Use of Direct Reading Spectrochemical Analysis of Magnesium Alloys,"* METAL PROGRESS, May, 1946, vol. 49, no. 5, pp. 947-955.

A detailed comparison of the direct reading method with the conventional photographic method is made. Factors such as the relative costs of the equipment, costs per analysis, relative accuracy, and operating personnel are considered.

The present and future applications of direct reading spectrochemical analysis are discussed with reference to the type of standard equipment which will be available commercially in a year or two.

Binders

THERMOSETTING. (See *Cores, Dielectric Heating.)*

Brass and Bronze

BRONZE. Rose, Kenneth, *"Engineering Bronzes,"* MATERIALS AND METHODS, April, 1946, vol. 23, no. 4, pp. 1027-1042.

A comprehensive discussion of bronzes having properties which approach those of steel. Included in the discussion are a general classification, nonhardenable bronzes, hardenable bronzes, methods of fabrication, and forms and finishes.

DEFECTS. Morey, R. E., and Kattus, J. R., *"Preventing Veining and Penetration on Castings Made in Synthetic Sands,"* AMERICAN FOUNDRYMAN, June, 1946, vol. 9, no. 6, pp. 53-63.

The occurrence, causes, and methods of eliminating veining and penetration from bronze castings.

DIE CASTINGS. Chase, Herbert, *"Brass Forgings or Die Castings—Which?"* MATERIALS AND METHODS, April, 1946, vol. 23, no. 4, pp. 995-1001.

A discussion of design and physical factors which affect the choice of method for producing brass parts.

PHOSPHOR BRONZE. (See *Copper-Base Alloys.)*

Centrifugal Casting

GERMAN METHODS. *"Centrifugal Casting in Germany,"* THE IRON AGE, July 25, 1946, vol. 158, no. 4, pp. 46-48.

A condensation of a report by James T. MacKenzie on the status of centrifugal casting practice in Germany immediately after V-E day.

Copper-Base Alloys

PHOSPHOR-BRONZES. Gradsky, Vladimir A., *"A New Copper-Phosphorus-Lead-Nickel Alloy."* METAL PROGRESS, May, 1946, vol. 49, no. 5, pp. 970-972.

Constitution of the new alloy, a description of its foundry practice, and a summary of its advantages.

Cores

DIELECTRIC HEATING. Wise, Ray T., Clark, L. E., and Salzberg, H. K., *"Drying of Foundry Sand Cores by Dielectric Heat,"* INDUSTRIAL HEATING, July, 1946, vol. 13, no. 6, pp. 1179-1180, 1182, 1184-1189.

A description of dielectric heating, core-drying experiments, improvements and practical advantages, certain changes in core practice necessary, and a discussion of costs.

DIELECTRIC HEATING. Wise, Ray T., and Moran, James P., *"Rapid Baking of Foundry Cores by Dielectric Heating,"* MATERIALS AND METHODS, May, 1946, vol. 23, no. 5, pp. 1307-1312.

A combination of electronic heating and thermosetting binders makes it possible to produce superior cores so rapidly that baking is at production-line rates.

MAGNESIUM FOUNDRY. Kurachek, George W., *"Magnesium Foundry Core Practice,"* THE FOUNDRY, September, 1946, vol. 74, no. 9, pp. 76-77, 162, 164, 166, 168, 170.

Developments in core binders and inhibitors aimed at reducing core and casting scrap, decreasing baking temperature and/or time, reducing direct labor costs, and decreasing casting cleaning costs.

MALLEABLE FOUNDRY. Sawtelle, D. F., *"Malleable Foundry Coremaking Practice,"* AMERICAN FOUNDRYMAN, June, 1946, vol. 9, no. 6, pp. 71-74.

Core sand in a mechanized malleable foundry making pipe fittings and small castings must primarily meet the requirements of the core shop in making cores which, after performing its functions in molds, becomes the basis for a satisfactory molding sand.

Corrosion Resistance

NICKEL ALLOYS. (See *Nickel-Base Alloys.)*

Defects

ELIMINATION. Johnstone, George, Jr., *"Elimination of Casting Defects,"* THE FOUNDRY, September, 1946, vol. 74, no. 9, pp. 92-95, 210, 212, 214-215.

A description of the classification and prevention of defectives and inspection methods.

Furnaces

REPAIR AND MAINTENANCE. *"Open-Hearth Repairs and Maintenance,"* INDUSTRIAL HEATING, August, 1946, vol. 13, no. 8, pp. 1346, 1348, 1350, 1352.

A discussion of labor saving devices, bottom materials, and bottom maintenance.

AIR FURNACE. Forbes, Duncan P., *"Air Furnace Cast Iron,"* CANADA'S FOUNDRY JOURNAL, July, 1946, vol. 19, no. 7, pp. 5-6, 8-9.

A description of present-day air furnaces, production methods used for gray cast iron, and a discussion of the characteristics of air-furnace gray cast iron.

Gray Cast Iron

ANALYSIS. (See *Spectrographic Analysis.)*

DEVELOPMENTS. Vennerholm, G., *"Developments in Gray Iron and Malleable,"* METAL PROGRESS, June, 1946, vol. 49, no. 6, pp. 1163-1168.

An analysis of wartime developments in malleable iron and gray cast iron, including melting practice, basic cupola, inoculants, mold atmosphere, heat treatment, cast iron crankshafts, and centrifugal brake drums.

METALLURGY. Lindsay, R. W., *"The Metallurgical and Engineering Status of Cast Irons,"* AMERICAN FOUNDRYMAN, June, 1946, vol. 9, no. 6, pp. 31-34.

An account of the application of metallurgical principles to produce a cast iron with improved engineering properties.

WEAR RESISTANCE. Sefing, F. G., *"Gray Iron Wear Resistance,"* AMERICAN FOUNDRYMAN, June, 1946, vol. 9, no. 6, pp. 77-79.

A comparison of gray irons, illustrating the relationship of wear resistance to microstructure.

Japanese Foundry

DESCRIPTION. Den Breejen, A. C., *"Japanese Foundry Industry Found Inferior,"* AMERICAN FOUNDRYMAN, June, 1946, vol. 9, no. 6, pp. 81-82.

A description of sand techniques, molding tools, and products.

(Continued on Page 94)

NEW PRODUCTS

Exothermic Ferrosilicon

Chromium Mining & Smelting Corp., Ltd., Sault Ste. Marie, Ontario, Can., now offers in granular form "Sil-X" exothermic ferrosilicon, first introduced in briquets, and developed for several applications in the iron foundry or steel plant. Both No. 145 and No. 217 are available in the granular condition. The former is used for chemistry in the ladle and for greater recoveries of silicon where low silicon pig iron and larger quantities of steel scrap are used; the latter for promoting fluidity when temperature of the metal is low and thin sections are to be poured without pre-heating or washing of ladles. Both are designed to eliminate porosity.

Crucibles

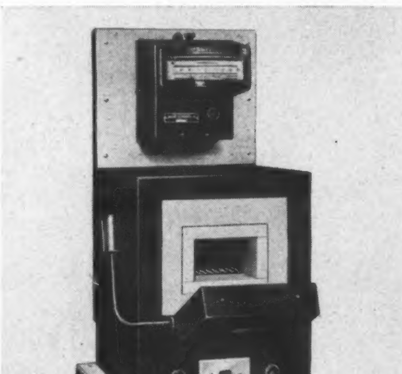
Electro Refractories & Alloys Corp., Buffalo 2, N. Y., introduces its new line of "Tercod Conqueror Crucibles" for all copper alloys, with an invitation to foundrymen to take advantage of outstanding gains in quality, quantity and durability. Increases in properties listed are: strength, 31.5 per cent; heat conductivity, 10 per cent; resistance to flame, 33 per cent; resistance to metals and slags, 12 per cent; thermal flexibility, 10 per cent, and density, 5 per cent.

Pattern Plate

The Kindt-Collins Co., 12651 Elmwood Ave., Cleveland 11, suggests a number of distinct advantages for its new type pattern plate, the "Master Cast and Ground Flat Aluminum Tuff-Plate." Features include a number of knurled steel inserts, cast integrally with the plate and designed to increase plate life by reducing wear by flasks to a minimum; three standard ears at each end to accommodate all types of flask pin guides; special machining of plate surface to prevent sand slippage; rounded edges for easy handling; and spacing of inserts around perimeter in such manner as to equalize wear.

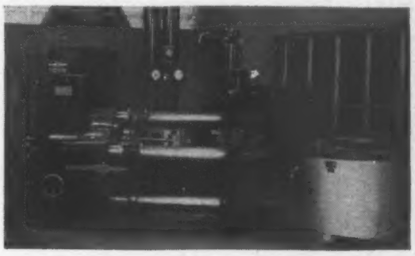
Precision Furnace

K. H. Huppert Co., Chicago 37, has designed a new high temperature furnace, known as Huppert "Hi-Temp," for small capacity precision heat treatment and recommended for continuous operation at temperatures up to 2200° F., and intermittent operation up to 2250° F. Features are automatic temperature control; all-steel, heavy-duty construction; two pilot lights, one to indicate operation, the other any failure occurring in heating elements; counterbalanced door; and black wrinkle finish. Available in floor and table models. Operates on 110V, AC only—current consumption 2KW.



Die Casting Machine

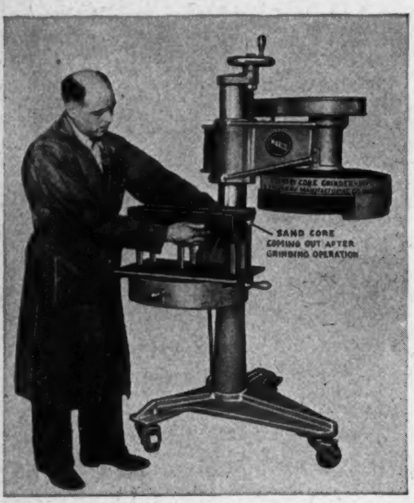
Hydropress, Inc., New York, displayed "Hydrocast" Model 3, of a new line of six sizes of cold chamber die casting machines, in actual operation at the Golden Jubilee Foundry Show in Cleveland. Incorporating many automatic and semi-automatic features, the machines are built according to individual requirements for water-hydraulic or oil-hydraulic operation with copper, aluminum, magnesium and zinc alloys. Injection pressure ranges from 10 to 190 tons, with castings volumes of 3 to 300 cu. ft.



Portable Mullor

Beardsley & Piper Co., Chicago, announces addition to its line of portable mullors for large and small foundries of a completely new unit, "Model No. 7 Mulbaro." Engineering improvements designed for faster, more convenient mulling of both molding and core sand and lower cost of maintenance feature the new Mulbaro, which has greater ease of mobility and double the capacity of earlier models. Two separate units comprise the model; a three-wheeled barrow for transporting sand and holding it during mulling; and the mulling mechanism, operated by an electric motor and suspended by a chain on which it is lowered for

attachment to the barrow during operation. Barrow dumps sand without shovelling through a spring mechanism which raises bowl to 90°; and bowl is tipped back to 45° during refilling, weight of sand forcing it to level position.

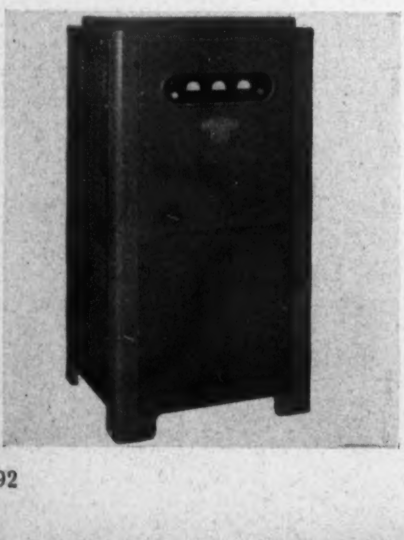


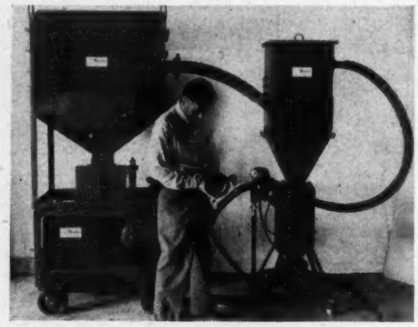
Core Face Grinder

D. J. Murray Mfg. Co., Wausau, Wis., offers a portable production machine for grinding sand core faces before pasting cores together. Known as "Murco Foundry Core Grinder," the unit has a maximum clearance of 18 in. between grinding wheel and table faces, is mounted on casters to permit movement to any portion of core room, and requires floor space of 3x5 ft. Adjustable grinding head may be locked in desired position. Small cores are ground in multiple in fixtures, increasing production.

Dual-Purpose Electronic Heater

Induction Heating Corp., 389 Lafayette St., New York 3, recently developed a single unit suitable for both induction (metal) and dielectric (non-metal) heating operations, the "Ther-Monic M-285C Electronic Heating Generator," especially designed for use in experimental laboratories and developmental research departments. The generator is provided with two, interchangeable, oscillator sections: changeover is accomplished by removing one and replacing it with the other. Operates on 205-245-volt, 60-cycle, single-phase power supply. Full load output is 285 Btu. per minute or approximately 5 kw. at nominal frequencies of 375,000 cycles per second, for induction heating, and twenty million cycles per second for dielectric heating.





Blast Cleaner

Vacu-Blast Co. Inc., 1054 Broadway, Burlingame, Calif., is now in production with "The Vacu-Blaster," a new blast cleaner designed to revolutionize methods of cleaning metal, concrete, or other hard surfaces. Unique feature of the unit is a vacuum return system, said to permit no abrasive or other particles to escape into the open; obviate need for masks, goggles or protective clothing; and allow cleaning to be undertaken without interruption of other operations in the immediate vicinity. Blast is controlled by a switch at the gun through which it is directed, and through which grit and dust are picked up. The grit and refuse are continuously returned to a reclaiming tank, where re-usable particles are salvaged and dumped into the blasting system, while other material is shunted to a dust collector.

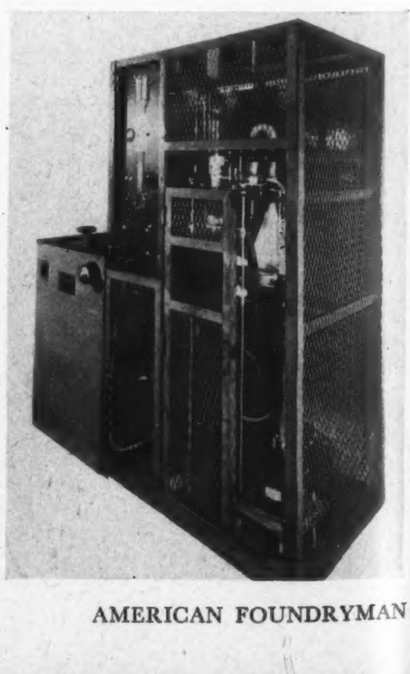
Scribing Plate

Eastman Kodak Co., Rochester 4, N. Y., has developed the "Kodak Green Scribing Plate," for use with optical comparators of the contour projection type. May be used directly with comparator, as printing

master for duplicating contour plate, or for making small photo templates on metals and other materials. Lines are scribed directly on a transparent, green-dyed gelatin coating on the plate, an operation that may be left in the hands of a skilled draftman. Emulsion will not chip, the company reports. Use of a supplemental red light behind the plate bring tolerance limits in shadowed areas into sharp relief (see cut), showing as red lines against a dark green background.

Oxygen Determination Unit

Central Scientific Co., 1700 Irving Park Rd., Chicago 13, announces its new "Cenco-Derge" unit for determination of oxygen content of open-hearth melts, and states that less than ten minutes is required for an accurate analysis while the heat is still in the finishing period. Sample is melted in an induction furnace under vacuum; oxides are reduced by carbon present in the graphite furnace crucible; and the resulting carbon monoxide is measured. Percentage of oxygen is then computed by a simple equation. Unit is completely enclosed in a steel frame.



Abstracts

(Continued from Page 90)

A description of sand techniques, molding tools, and products.

Magnesium-Base Alloys

APPLICATIONS. Hanawalt, J. D., *"Industrial Significance of the Basic Characteristics of Magnesium,"* METAL PROGRESS, April, 1946, vol. 49, no. 4, pp. 739-743.

A discussion of the possible applications for which magnesium-base alloys may be suited because of their characteristics.

MELTING POTS. Keller, A. V., *"Magnesium-Melting Pot Life Increased by Sprayed Special-Alloy Coating,"* INDUSTRIAL HEATING, December, 1945, vol. 12, no. 12, pp. 2074, 2076, 2078, 2080.

A discussion of the causes of short pot life, pot defects which accelerate failure, coating procedure, checking and recording service performance, and comparative-life data on melting pots.

SERVICEABILITY. Found, George H., *"Magnesium Alloy Castings — Relative Significance of Design and Metallurgical Factors of Serviceability,"* AMERICAN FOUNDRYMAN, June, 1946, vol. 9, no. 6, pp. 43-49.

Design and metallurgical factors which affect fatigue properties and serviceability.

Magnetic Separators

VENTILATION. Hermann, C. C., *"Ventilating Separators, Breakers, Screens,"* THE FOUNDRY, September, 1946, vol. 74, no. 9, pp. 97, 215-216, 218.

A discussion of the dust points in connection with magnetic separators and methods by which the dust can be controlled.

Nickel-Base Alloys

CORROSION RESISTANT. *"Corrosion-Resistant Alloys,"* STEEL, July 29, 1946, vol. 119, no. 5, pp. 70-75, 112.

A description of four high-strength, nickel-base alloys which find wide use in industries handling such reactive acids as boiling hydrochloric, sulphuric and hot nitric acids. Their range of application is indicated.

Pattern Making

DESIGN. Manwell, W. C., *"Patterns in the Jobbing Foundry,"* NASSAU, May, 1946, vol. 8, no. 5, pp. 3-11; June, 1946, vol. 8, no. 6, pp. 3-9.

A discussion of the principles of designing and making good patterns to enable jobbing foundries to produce castings as economically as possible.

Patterns

STORAGE. Cech, Frank C., *"Pattern Vaults Require Planning,"* THE FOUNDRY, September, 1946, vol. 74, no. 9, pp. 66-71, 210, 212, 214-215.

An analysis of the factors involved in storing patterns, and information which might be used to solve individual storage problems.

Pig Iron

DEVELOPMENTS. Johnston, T. G., *"50 Years Progress in Pig Iron,"* AMERICAN FOUNDRYMAN, June, 1946, vol. 9, no. 6, pp. 36-40.

Early developments; alloy sensitivity; improved production; furnace design; melt components; cost reductions; grading system; analysis variation; improved standards.

Precision Casting

METHODS. Cady, Edwin Laird, *"Precision Investment Castings,"* MATERIALS AND METHODS, March, 1946, vol. 23, no. 3, pp. 741-760.

A comprehensive discussion of precision castings and their design, metal composition, plant practice, patterns and molding.

PRODUCTION METHODS. *"Mass Production of Precision Castings,"* MATERIALS AND METHODS, April, 1946, vol. 23, no. 4, pp. 1016-1020.

A pictorial description of methods used by Haynes to achieve mass production of precision castings.

Pyrometry

IRON AND STEEL. Clark, H. F., *"Recent Developments in the Pyrometry of Liquid Iron and Steel,"* IRON AND STEEL ENGINEER, February, 1946, vol. 23, no. 2, pp. 55-63, 80.

A discussion of temperature measurement of molten ferrous metals over the range of 2600 to 3100 degrees F. by means of quick immersion thermocouples and open-end tube immersion pyrometers.

LIQUID STEEL. Manterfield, D., *"Temperature Measurement of Liquid Steel,"* THE IRON AGE, July 25, 1946, vol. 158, no. 4, pp. 52-57.

A review of the progress of liquid steel pyrometry in Britain and a detailed description of the latest type of immersion thermocouple equipment.

OPEN-HEARTH FURNACES. *"Measurement of Temperature in Open-Hearth Furnaces,"* INDUSTRIAL HEATING, August, 1946, vol. 13, no. 8, pp. 1318, 1320.

A discussion of the techniques and instruments employed in the measurement of temperature in various phases of open-hearth operation.

THERMOCOUPLES. Manterfield, D., and Thurston, J. R., *"Improvement in Design of Immersion Pyrometers for Liquid Steel Temperatures,"* THE IRON AND STEEL INSTITUTE, Advance Copy, June, 1946, 5 pp.

An improved design of immersion thermocouple consisting of a semi-permanent fixture attached to the back-wall furnace binding and manipulated through the back-wall of the furnace by means of a light jib is described. The apparatus is easy to manipulate, requires only one operator, and its maintenance is of a very small order. Details of the construction and use of the apparatus are given, together with accounts of behavior in practice.

A steel end-black, which has an extremely long life and the use of which has eliminated troubles with embrittlement of the rare-metal couple wires, is also described. References are made to other improvements which are contemplated, including an all-steel arm for the back-wall installation.

Radiography

DEVELOPMENTS. Evans, M. B., *"Technique and the Future of Industrial Radiography,"* INDUSTRIAL RADIOGRAPHY, Winter Number, 1945-1946, vol. 4, no. 3, pp. 19-22.

A review of most of the wartime improvements in X-ray technique with an analysis of the effects of these improvements on postwar usage.

MICRORADIOGRAPHY. Maddigan, S. E., *"Microradiography,"* INDUSTRIAL RADIOGRAPHY, Spring Number, 1946, vol. 4, no. 4, pp. 22-25, 28-30.

The development of the microradiographic method is traced from the early absorption experiment by Haycock and Neville. Details of the modern technique are given considering the use of a single tungsten target with variable voltage as well as the use of several target elements with a variety of characteristic wave lengths. The absorption effects are explained by analogy with visible light. Numerous applications are discussed.

Refractories

ELECTRIC FURNACE. Pryor, E. K., and Burke, L. R., *"Refractories for Electric Melting in the Ferrous Foundry,"* AMERICAN FOUNDRYMAN, January, 1946, vol. 9, no. 1, pp. 55-60, 75.

Service conditions for electric furnace refractories are unusually severe. Improvements in refractories have helped to prolong the life of refractories and simple precautions in furnace operation will prolong the life even more.

Safety and Hygiene

GOOD HOUSEKEEPING. Thomson, James, *"Cleanliness and Safety in the Foundry,"* AMERICAN FOUNDRYMAN, January, 1946, vol. 9, no. 1, pp. 48-49.

A discussion of the way in which cleanliness can improve production economy.

Spectrographic Analysis

GRAY CAST IRON. Hurst, J. E., and Riley, R. V., *"Routine Spectrographic Analysis of Cast Iron,"* CANADIAN METALS AND METALLURGICAL INDUSTRIES, August, 1946, vol. 9, no. 8, pp. 23-29.

The technique for rapid and accurate analysis of a variety of plain and alloy cast irons.

Steel

BOMB CASTINGS. Gray, Basil, *"Producing Bomb Castings by Use of the Core Barrel,"* AMERICAN FOUNDRYMAN, June, 1946, vol. 9, no. 6, pp. 22-30.

A description of a British method of

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Firm Facts

International Nickel Co. Inc., announces the opening of the Texas section of its development and research division, with headquarters in the Bankers Mortgage Building, Houston, Texas. Activities of the section will cover Texas, Oklahoma, Louisiana, Mississippi and the southern half of Arkansas, and will be designed to furnish industry with technical information and assistance relating to alloys containing nickel.

Stainless Foundry & Engineering Co., 5132 N. 35th St., Milwaukee, is a new firm organized for production of stainless steel castings for the food and chemical industries, and equipped with a direct arc electric melting furnace of 500-lb. capacity, designed by the partners, H. W. Kutchera and John McBroom. The foundry is designed to handle castings up to 300 lb. in weight.

Organization of the **Taco West Corp.,** 2620 South Park Avenue, Chicago 16, has been announced by T. A. Cohen, president. The new firm will manufacture and market automatic electronic control devices in the fields of combustion control, gas analysis, pyrometry and process control, as well as allied apparatus.

Sales development and engineering service divisions of **Allegheny Ludlum Steel Corp.,** Pittsburgh, Pa., have been consolidated under managership of W. B. Pierce. Functions of the new department will be to co-ordinate and extend the company's cooperation with users and fabricators of stainless steel on their problems of applications. Special attention will be given to the development of new markets for the introduction of new alloys.

All duties and activities of **E. I. du Pont de Nemours & Co.,** Wilmington, Del., in the atomic energy program were concluded as of August 31, in accordance with a re-

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Firm Facts

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quest made by the firm at the time the work was undertaken in the fall of 1942. At that time, the company asked that it be relieved of the task as soon as practicable, according to W. S. Carpenter, Jr., president.

"In this job," he added, "we have had the whole-hearted support of tens of thousands of men and women who joined us in accomplishing unprecedented tasks. Although there were many unknown dangers, there has not been a major injury due to hazards inherent in the process. The job done at Hanford Engineering Works, Richland, Wash., is the greatest testimonial to the performance of the employees. I want to add my thanks."

Link-Belt Co., Chicago, announces establishment of a general engineering division, with headquarters at 1955 W. Hunting Park Ave., Philadelphia. The division will serve the entire company, augmenting product development and standardization activities heretofore conducted at individual plants; and will be under the general supervision of R. F. Bergmann, company vice-president in charge of engineering, with offices in Chicago.

Canadian Bronze Co. Ltd., Montreal, Que., marked the 50th anniversary of the granting of its charter with a luncheon in the Mount Royal Hotel recently. All senior executive officers of the company were among the 250 in attendance, as were representatives and guests from such scattered points as New York, Toronto, Winnipeg, St. Louis and Chicago .

More than 1,000 citizens of Grinnell, Iowa, accepted an 'open house' invitation to the formal opening, August 9, of the new foundry established there by **Lennox Furnace Co.**, Marshalltown, Iowa. The new cement block and steel structure has been designed for safety and pleasant working conditions, and has modern equipment.

Personalities

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York, before entering the Navy in 1944, is now associated with Lester B. Knight & Associates, Inc., Chicago. **J. F. Bork** also joins the Lester B. Knight firm following release from the Navy. A member of A.F.A., Mr. Bork was affiliated with the Wisconsin chapter prior to his service career.

W. L. Lewis, since 1931 executive vice-president, Chicago Pneumatic Tool Co., New York, has been elected president, succeeding **H. A. Jackson.** Mr. Jackson, who resigned at his own request after 28 years as president, was re-elected chairman of the board, in which capacity he has served for 14 years.

W. Hessenberg of the British Non-Ferrous Metals Research Association in England was a recent visitor at the A.F.A. National Office. Mr. Hessenberg is in this country studying some administrative practices of non-ferrous foundries, on assignment by the British Government. His society has long played an active part in non-ferrous foundry work over seas.

G. A. Rentschler, president, General Machinery Corp., Hamilton, Ohio, has been elected to the new position of chairman of the board. **Walter Rentschler,** vice-president and treasurer, has advanced to president; and **J. E. Peterson** and **A. C. Wais** have been named vice-presidents.

H. W. Kutchera and **John McBroom,** both formerly engineering consultants, are partners in the new Stainless Foundry & Engineering Co., Milwaukee, established for production of stainless steel castings and equipped with a new direct arc electric melting furance of their own design.

Mr. McBroom, a graduate of the University of Minnesota, Minneapolis, and member of the Wisconsin A.F.A. chapter, was associated with production work on stainless steel castings with Duraloy Co., Scottsdale, Pa., prior to operating his own consulting service in Chicago. Mr. Kutchera, graduate of the University of Wisconsin, Madison, entered consulting work after association with the methods department at Chain Belt Co., Milwaukee, and product design at Waukesha Motor Co., Waukesha, Wisconsin.

Q. D. Mehrkam, who has been associated with Thompson Aircraft Products Co., Cleveland, as production metallurgist, moves to the Ajax Electric Furnace Co., Inc., Philadelphia, as a member of the metallurgical staff; and will be engaged in developing new processes and in experimental heat treatment of manufacturers' specimens in the Ajax research laboratory.

J. G. Goldie, for the past 17 years head of the foundry department, Cleveland Trade School, Cleveland, resigned that position October 1 to become general superintendent, M.B.M. Foundry, Inc., Cleveland, a

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Abstracts

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producing castings for "grand slam" and "tallboy" bombs, utilizing a core barrel.

COPPER. Taylor, H. F., Bishop, H. F., and Wayne, R. C., *"Copper and the Steel Casting,"* AMERICAN FOUNDRYMAN, May, 1946, vol. 9, no. 5, pp. 72-83.

A review of studies of earliest investigators and a study of other characteristics of copper alloy steels. The excellent casting characteristics and high physical properties which can be developed in both light and heavy sections makes copper alloy steels of special interest for castings.

CRITICAL POINTS. *"A Review of the Steel Standardization Group's Method for the Determination of Critical Points of Steel,"* METAL PROGRESS, June, 1946, vol. 49, no. 6, pp. 1169-1171.

A description of a precision method based on dilalometric methods for determining the critical points of commercial steels.

Some precautions are given for the interpretation of data for steels whose S-curve has a double loop.

DEOXIDIZERS. *"Deoxidizers in Steel Making,"* INDUSTRIAL HEATING, August, 1946, vol. 13, no. 8, pp. 1314, 1316.

A discussion of relative efficiencies of various deoxidizers used in steel making, and some of their incidental effects.

HEAT TREATMENT. Howe, E. E., *"Effect of Heat Treatment on Steel Castings,"* THE FOUNDRY, September, 1946, vol. 74, no. 9, pp. 98-99, 194-195, 198-200, 202, 204, 206.

Discussing only the basic principles of heat treating, the author presents an easily understood explanation of what happens when steel castings are heat treated and the benefits to be derived from such operations in the way of improved physical properties.

HISTORY OF CASTINGS. Gregg, A. W., *"50 Years of Progress in Foundry Steel Melting,"* AMERICAN FOUNDRYMAN, May, 1946, vol. 9, no. 5, pp. 58-69.

A survey concerned primarily with the development of steel melting methods and equipment as applied to the steel casting industry. Some historical data pertaining to the earliest methods of making steel have been included because of their importance and connection with the history of steel foundry melting equipment.

Training

METHODS. Henry, David D., *"Recruiting and Training Foundry Engineers,"* THE FOUNDRY, September, 1946, vol. 74, no. 9, pp. 96, 220, 222, 224, 226.

A discussion of what the foundry industry should do if it expects to attract young engineers to its ranks.

PROGRAMS. Hunt, Fred W., *"A Program for Foundry Training,"* THE FOUNDRY, September, 1946, vol. 74, no. 9, pp. 72-75, 158, 161-162.

A comprehensive training program developed at Lynchburg Foundry Company.

Personalities

(Continued from Page 106)

new firm specializing in high test gray iron castings.

Mr. Goldie, a native of Scotland where he was educated and served his foundry apprenticeship, came to this country 23 years ago as a journeyman. He was associated with several foundries in the east, before entering the trade school field in the foundry department, State Trade School, Meriden, Conn.

Author of many courses on all phases of foundry work, including the first for the National Defense Training program, Mr. Goldie has long been identified with the A.F.A. Apprentice Training Committee and has served as Chairman of that group. He has also served as Chairman, Northeastern Ohio A.F.A. chapter.

Obituaries

Nelson Westover, retired foundryman of Lincoln, Nebraska, and a pioneer of the foundry industry in that state, died September 18 at Lincoln.

Mr. Westover, who operated a blacksmith shop until the need for castings became apparent and then added a structural shop and a foundry for making structural castings to his business, had lived in Nebraska since its days as a Territory, having gone there as a boy with his parents.

He was the father of C. E. Westover, Westover Engineers, Milwaukee, who served as Executive Vice-President and Treasurer of A.F.A. before organizing his own firm, and the grandfather of J. A. Westover, who is associated with that firm.

Adolph F. Kiefer, until his retirement last year a foundry superintendent, Ohio Pattern Works & Foundry Co., Cincinnati, died recently at his home.

A member of A.F.A., Mr. Kiefer was active in the Cincinnati District chapter. He was also president of the Pattern Manufacturers Association, a member of the Employment Managers Club, Cincinnati, and a director of the Grand Central Building Association.

Index to Advertisers